CIVIL LAND REMOTE SENSING SYSTEMS

JOINT HEARINGS
BEFORE THE
SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS
OF THE
COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
AND THE
SUBCOMMITTEE ON
SCIENCE, TECHNOLOGY, AND SPACE
OF THE
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SCIENCE, AND TRANSPORTATION
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CIVIL LAND REMOTE SENSING SYSTEMS

WEDNESDAY, JULY 22, 1981

U.S. SENATE, COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION, SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE; HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,

Washington, D.C.

The subcommittees met at 9:30 a.m., in room 235, Russell Senate Office Building; Hon. Harrison H. Schmitt, chairman of the Subcommittee on Science, Technology, and Space of the Senate Committee on Commerce, Science, and Transportation; and Hon. Ronnie G. Flippo, chairman of the Subcommittee on Space Science and Applications of the House Committee on Science and Technology, presiding.

Present: Senator Schmitt; Representatives Flippo, McGrath, Nelson, and Lowry.

OPENING STATEMENT BY SENATOR SCHMITT

Senator SCHMITT. The hearing will come to order.

Let me welcome all of you, ladies and gentlemen, to the first 2 days of joint hearings on the issue of establishing an operational Earth resources sensing system. I am particularly pleased that the House Science and Technology Committee and the Senate Commerce, Science, and Transportation Committee are joining together in this effort and hope that together with the administration, we will be able to search out and find a comprehensive new policy in this area for the country.

I am particularly excited by the increasing number of opportunities that the two committees are going to have to work together. It seems to me that it certainly should be to the benefit of all if we can develop these policies together and march down the legislative path without some of the problems that may have resulted in the past because we didn't communicate as often as we should. It's good to have you here.

Remote sensing is an art in science that has been around for a long time. First and foremost, in the form of man's eyes. We are very far from duplicating with instruments and systems the capabilities of those eyes and their unbelievably sophisticated data processing system that we call the brain.

However, we have learned over the past decade to vastly extend our reach and increase our knowledge of the Earth and its resources through satellite high altitude aircraft sensing systems. These relatively new technologies have contributed to making visible and useful that which was previously hidden and wasted.

It is this extension of our ability to use our eyes and brain to observe, integrate, synthesize, interpret, and apply that we have come to know as remote sensing.

The need for modern Earth resources information and the institutional base to serve those needs has developed slowly in spite of the obvious potential of such information. Unlike the telecommunications and weather data, remotely gathered resources information was not in general use prior to the space age since it was not available except in the form of standard aerial photography.

"The instruments carried by the American satellites of the TIROS and NIMBUS series in the 1960's, which offered a ground resolution of the order of 1,000 meters, were the first to reveal the potential of space as a vantage point. Second-generation remote sensing instruments with a resolutioin on the order of 100 meters were developed during the 1970's for the Landsat series of satellites. The images they returned enabled many users to become familiar with a new type of data and to develop the methods required for their interpretation. The 1980's will see the introduction of satellite-borne instruments with resolutions in the order of 10 meters, which will open up many new fields of application."

Now that last quote is from the introduction of the brochure the French are distributing for the SPOT system.

It continues to say: "The benefits of Earth observation data obtained from space are such that France decided in 1977 to go ahead with the SPOT program and to plan for a 1984 launch date."

The United States has traditionally not been very good of taking advantage of the technology we develop and as we are seeing in this area as well as others, other countries are capitalizing on our investments.

The Congress has been involved in the issue of developing an operational remote sensing system for the past 5 years. These efforts resulted in a Presidential directive last year that carried with it the potential of costly bureaucratic reorganization. We now have a new administration and what I hope will be a fresh look at a new opportunity to get at how we will get this system operational with maximum private sector involvement and minimal Federal investment and maximum benefit to the American people, and to mankind.

The purpose of these 2 days of hearings are to set a basis for a policy decision, not to make such a decision. It is an opportunity to discuss what are some of the changes that have taken place since our hearings last year, both with the private sector as well as with the new administration.

It is my hope that from these hearings, the Congress and the administration can work together over the next few months to outline a policy that will put this country back in its leadership role, and that we will move expeditiously in establishing the framework to fully take advantage of the obvious benefits that will accrue from an operational Earth resources information system.

I might add that in his confirmation hearings the other day, Jay Keyworth, the President's Science Adviser, did indicate to me, gentleman, that his first major policy formulation effort is in the space field, and presumably will include examination of this issue. We certainly are encouraging him to do that.

Congressman, do you have an opening statement?

Representative **Flippo**. Thank you, Mr. Chairman. First of all, let me say that the Nation is very fortunate. It's seldom that the Nation has a man who has the keen insight and knowledge that you have serving in the capacity that you're serving. The Nation is indeed fortunate and we look forward to working with you in all aspects.

I do have a brief opening statement. We are today, of course, considering land remote sensing from space, a subject that we've all followed for many years, and the capability to use space to gather information on minerals and crops, water supplies and other areas which will certainly be a signficant element of our national wealth and security when it is fully developed.

It's certainly very likely that in the long run, the private sector will have a lengthy role in operating our Nation's remote sensing capability. The questions are how and when should the private sector become involved in operating land remote sensing systems.

Up to now, industry has participated in a limited number of NASA R. & D. projects as data users. But the operation of the satellites and the ground systems have been totally Federal.

When should the responsibility for operations be transferred to the private sector? The general answer is obvious: Certainly, not before it can become truly private. There must be a commercial market which may not now exist. And how should the transfer be made?

Again, certain general principles seem to be obvious. We should insure that the system does contribute to the national wealth, as it potentially can. We should not create a permanent monopoly which would stifle innovative competition. And we must allow for growth and we must continue to meet our international obligations.

Within such general considerations, I'm convinced that we can find a specific solution which will be in the best interests of the Nation. Certainly, if one looks at the history of agriculture, of aviation, of satellite communication, one sees areas where federally developed technology has increased our Nation's wealth and security immensely.

I believe that the hearings that we are opening today are a step in that process, and I'm glad that we're able to have these hearings jointly with Senator Schmitt and others on his committee, and I will call it working together on this most important and challenging question.

Thank you, Mr. Chairman.

Senator **Schmitt**. Thank you, Congressman Flippo. Congressman Nelson?

Representative **Nelson**. No, thank you, Mr. Chairman.

Senator **Schmitt**. Congressman McGrath?

Representative **McGrath**. No, thank you, Mr. Chairman.

Senator **Schmitt**. OK. Our first panel, if we may bring them up, it will be: Mr. James Beggs, Administrator of NASA; Mr. Joe Wright, Deputy Secretary of the Department of Commerce, individuals that represent what we might say are the current operational entities within the Federal Government. Obviously, the Department of the Interior, the Department of Agriculture and others have a tremendous stake in this. So that at this point, whatever operational system is in place, it is the responsibility of these two organizations.

We would ask Mr. Wright to begin with his statement. And we understood, Jim, that you do not have an opening statement, but you may have a few comments to make before we begin the questioning.

Mr. Wright?

STATEMENT OF JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, AND JOSEPH WRIGHT, DEPUTY SECRETARY, DEPARTMENT OF COMMERCE

Mr. WRIGHT. Good morning, Mr. Chairman. It seems like when you and I get together, we're talking about issues that belong to the future of this country, and important issues, whether it be strategic minerals and materials or land satellites.

Senator SCHMITT. If I had my way, we'd change the name of our two committees to the "Committees of the Future."

That's really what we're talking about.

Mr. WRIGHT. I just want to say that I applaud your effort, and the subcommittees' efforts, because I do believe that you are dealing with very important issues.

I have a 10-page statement that I'd like to submit for the record. I shall briefly summarize it and then get into questions and answers.

The administration has been planning for the establishment of operational civil land remote satellite sensing by the United States for the past 18 months, with the intent of transferring the responsibility to the private sector as soon as possible. So far, we in the Department of Commerce are encouraged by the commercial potential of this transfer.

I'd like to discuss first the status of the planning of the interim satellite system, and second, some alternatives for private sector ownership and operation. First, the status.

NOAA is scheduled to assume operational responsibility for the two NASA-procured R. & D. satellites, Landsat D and D', after NASA has launched and fully tested the first of these satellites and its associated ground system. We are on schedule. The multispectral scanner will go into operation in 1983 and the thematic mapper will go into operation around 1985. NOAA will operate the D and D' satellites as long as they last, or until the private sector can being to provide land remote sensing data themselves.

In preparing for the interim operational system, we have two main goals: First, working with the interested Federal agencies and the user community to insure smooth Federal management of the interim system; second, determining the appropriate institutional framework for private sector takeover.

NOAA employees are already working with NASA and the Department of the Interior on preparations for the operation of the Landsat D system. They have developed a pricing proposal for products and services to recoup the cost of the system beginning in 1983.

We have established a Program Board on Civil Operational Land Remote Sensing from Space with officials from 11 Federal agencies to assist Commerce in planning and implementing the system. NOAA had conducted a series of user conferences with interested non-Federal groups in refining our analysis of user needs and requirements. We have established the 15-member Land Remote Sensing Satellite Advisory Committee to help the Department in its management of the interim system and on private sector activities in this area.

We are also working overseas to assure that we understand the impact of various pricing options on the expansion of foreign data use.

In summary, Mr. Chairman, we are on schedule and we are also encouraged by private sector interest.

Now there are several institutional alternatives that we could talk about for transferring responsibility for the program to the private sector. First, however, we need to consider the major objectives we wish to achieve. First, we have to make sure that we fulfill the data needs of American users, which does include the Federal Government. Second, we have to be sure that future expansion of the U.S. land remote sensing satellite industry is promoted, if not guaranteed. And third, we have to sit down and make sure that we satisfy foreign policy objectives.

In the Department's issues and options document that was submitted to the Congress in June of 1980, four institutional alternatives were analyzed:

First, an existing private corporation.

Second, a legislatively established for-profit private corporation.

Third, a Government corporation.

Fourth, Federal agency ownership with private sector operation.

There have already been indications of interest from several companies in this transfer. A precondition of their interest in almost all cases is that the Federal Government not operate a competing system.

Private sector involvement can take several forms. We could designate a single company by legislation or by sole-source selection. We could have competitive selection of a contractor or contractors. We can license companies or we can have joint Government-industry venture.

Each approach has positive and negative features, but unless there are compelling reasons to select a different alternative, we favor an approach that will promote competition in the private sector. Some legislation will be required for this.

The next steps we feel need to be taken include: First, reaching a decision on the type or types of private sector involvement; second, ascertaining the level of interest and the specific type of arrangement. This includes the economics and performance requirements. Third, obtaining an administration position. And finally, fourth, working with the Congress on legislation to implement the transfer as soon as possible.

Mr. Chairman, we look forward to working with you and the subcommittee on getting this done. Thank you.

[The prepared statement, plus answers to question asked of Mr. Wright follow:]

STATEMENT OF JOSEPH R. WRIGHT, JR.,
DEPUTY SECRETARY OF COMMERCE
ON CIVIL LAND REMOTE SENSING SYSTEMS
BEFORE
THE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE
OF THE COMMITTEE ON COMMERCE, SCIENCE
AND TRANSPORTATION
U.S. SENATE
AND
THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
JULY 22, 1981

Mr. Chairmen and Members of the Subcommittees:

I am pleased to be here today to discuss United States civil operational land remote sensing from space. The Administration has been planning for the establishment of operational civil land remote satellite sensing by the U.S. for the past eighteen months, with the intent of transferring the responsibility to the private sector as soon as possible. So far, we are encouraged by the commercial potential of the operational land remote sensing satellite business, and believe that private industry has the ability and the desire to engage in the business with a minimum of government interference.

The President's FY 1982 budget recommends that the Secretary of Commerce operate an interim operational system based on the Landsat D and D' satellites now being constructed by the National Aeronautics and Space Administration (NASA) until the private sector begins to engage in the business of land remote sensing from space.

Today, I would like first to bring you up to date on the status of planning the interim operational land remote sensing satellite system, and then discuss some alternatives for private sector ownership and operation.

1. Status of Planning the Interim Operational Land Remote Sensing Satellite Program

The National Oceanic and Atmospheric Administration (NOAA) in the Department is scheduled to assume operational responsibility for the two NASA-procured R&D satellites, Landsat D and D', after NASA has launched and fully tested the first of these satellites and its associated ground system. Preparations for the transfer of the assets to NOAA from NASA are proceeding on schedule. We expect to assume operational responsibility for the Multispectral Scanner on Landsat D early in 1983 and for the Thematic Mapper around 1985. NOAA will operate the Landsat D and D' satellites as long as they last or until the private sector can begin to provide land remote sensing data. Following the transfer of Landsat D and D' assets, NASA will continue its research in land remote sensing from space to help maintain U.S. technological leadership in this area.

The Secretary has submitted to this Congress a short bill authorizing continued planning for and management of the interim operational system by the Department. Similar legislation was included in H.R. 2803, a House Science and Technology Committee authorization bill for programs in NOAA.

In preparing for the interim operational system, we have two main goals: working with interested Federal agencies and the user community to ensure smooth Federal management of the interim system, and determining the appropriate institutional framework for private sector takeover.

We are preparing for Federal management of the interim operational system through both technical and administrative planning. For example, NOAA employees experienced in meteorological satellite programs are already working with NASA on preparations for the operation of the Landsat D system. NOAA has also begun discussions that will form the basis of memoranda of understanding with NASA covering the operational takeover of the interim system, and with the Department of the Interior covering the archiving and dissemination of data from the interim system at Interior's EROS Data Center.

The Department has developed a pricing proposal for products and services from the interim system that is currently under Administration review. The proposal is designed to recoup the costs of the system, starting in FY 1983.

The Secretary of Commerce has recently established a Program Board on Civil Operational Land Remote Sensing from Space. The Board will consist of Federal officials at the assistant secretary level from eleven Federal agencies and departments. The Board will assist Commerce in planning and implementing the interim operational system and private sector transfer.

NOAA has also conducted a series of user conferences with interested non-Federal groups aimed at refining our analysis of user needs and requirements. In addition, NOAA held three sessions in May to discuss concepts for private sector investment with representatives of companies that may be interested in investing in operational land remote sensing. Participants in the sessions were positive about the ability of private industry to enter the business of land remote sensing from space on an accelerated schedule, and offered specific comments on institutional arrangements that would allow them to do so. The Department will continue to meet with interested non-Federal groups on a regular basis through a 15-member Land Remote Sensing Satellite Advisory Committee. This Committee will advise the Department on its management of the interim system and on private sector activities in land remote sensing from space.

The Department also is participating in a series of regional meetings in Africa, Asia and South America to inform foreign data users of the products and services that will be available from the U.S. interim operational system and other national systems. We are also working with foreign Landsat ground station operators to assure that we understand the impact of various pricing options on the expansion of foreign data use.

In summary, the Department is on schedule in assuming responsibility for the interim operational system. We are encouraged by private sector interest in civil operational land remote sensing from space and believe that the Department can effectively facilitate the transition to a private land remote sensing satellite industry.

2. Institutional Alternatives for Land Remote Sensing

In order to evaluate institutional alternatives for operational land remote sensing, one must first consider the objectives of U.S. involvement in this activity. One objective is fulfilling the data needs of American users, including the Federal government. From the government's perspective, this includes meeting its data requirements with the best possible service at the lowest possible price.

At the same time, any institutional arrangement should allow for future expansion in the U.S. land remote sensing satellite industry. In addition, the Federal government must meet its foreign policy objectives and protect its national security. Under the Outer Space Treaty of 1967, the United States also must "authorize and continu[ously] supervise the activities of non-governmental entities" in outer space. Thus, some minimal government supervision will be necessary.

These are complex, but not unattainable, objectives. We believe they can best be met by transferring the responsibility for operational land remote satellite sensing to the private sector in an appropriate institutional setting.

In the Department's issues and options document on Planning for a Civil Operational Land Remote Sensing Satellite System submitted to the Congress in June, 1980, four institutional alternatives were analyzed:

- An existing private corporation;
- A legislatively established for-profit private corporation;
- A government corporation; and
- Federal agency ownership with private sector operation.

This Administration has concluded that the Federal government's current investment in Landsat satellites is sufficient to permit evaluation of the operational uses of Landsat data and, if these uses prove cost effective, to attract private sector investment.

Since this policy decision, there have been indications from several companies that the private sector is interested in undertaking operational land remote sensing from space without an extended period of government operation. Indeed, a precondition of private investment is that the Federal government must not operate a competing civil land remote sensing satellite system.

Private sector involvement can assume a number of different forms, including some combination of the following --

- designation of a single company by legislation or by sole-source selection;

- competitive selection of a contractor or contractors to provide data to meet the needs of Government user agencies;
- licensing of companies to engage in the business of land remote sensing from space; and
- joint Government-industry ventures.

Single Company Designation

By a sole-source contract or through legislative designation of a single company, the Government could choose one company to engage in land remote sensing from space. This approach could be used to minimize the financial risk to whichever company was selected, but it may be more costly to the Government than a competitive selection or open licensing process.

Competitive Selection

Under this approach a single Government agency would aggregate the needs of Federal user agencies and request competitive proposals from industry to meet those needs. Through competitive selection the Government would be able to choose from varying industry technical and financial proposals and to select the most advantageous. The competive selection process can also be used to encourage private companies to share a larger portion of the financial risk. However, the selection process takes time, and this could delay the transfer to the private sector of responsibility for land remote sensing from space.

Licensing

The Government could license companies to engage in the business of land remote sensing from space with minimum regulation for national security and foreign policy requirements. An advantage of this approach is that it allows private industry to meet a variety of land remote sensing needs. However, without a Government contract, licensees may not design their services to satisfy the broad needs of Federal agencies. Since the Federal government will probably be a significant user, such is unlikely.

Joint Ventures

The Government could collaborate with private companies in operational land remote sensing activities. For example, a company might contract to place a privately-owned sensor on a Government spacecraft or the Shuttle. A joint venture allows the Government to share in risk-taking, or share its assets for the mutual good, and it may alleviate the need for private companies to finance a completely independent system. A disadvantage of a joint venture is that it requires some form of federal involvement, a matter of concern to some private entities.

Conclusion

Unless there are compelling reasons to select a different alternative, we favor an approach that will promote competition in the private sector. We believe that competition in this newly emerging industry will best serve the nation's requirements for obtaining civil land remote sensing satellite data and fostering U.S. technological leadership. Some legislation will be required to implement such transfer of land remote satellite sensing responsibilities to the private sector. The next steps to be taken include: reaching a decision on the type(s) of private sector involvement, ascertaining a level of interest in the specific type of arrangement -- including the economics and performance requirements for both the private sector and the Federal government, obtaining an Administration position, and working with the Congress on legislation to implement the transfer as soon as possible. We look forward to working with you on this important matter.

QUESTIONS FOR MR. JOSEPH F. WRIGHT
SENATE COMMITEE ON COMMERCE, SCIENCE AND TRANSPORTATION

1. QUESTION: How might you see a licensing process work?

ANSWER: While NOAA has not developed a specific licensing process for corporations wishing to enter the business of land remote sensing from space, it believes that any licensing process should promote competition and should not impose undue regulation on licensees. The licenses should contain only those minimal terms and conditions necessary to meet U.S. national security and foreign policy requirements. The licensing agency should not engage in rate-making. Obtaining a license should be as simple as possible; for example, one-stop licensing with a simple, fast review procedure.

2. QUESTION: One of the major components in expanding the market for earth resources information is marketing in both the private and public sectors. What ideas do you have for the marketing of data?

ANSWER: In our view, companies considering investment in land remote sensing from space are in the best position to undertake these activities. In May 1981, NOAA held three sessions to discuss legislative concepts for private sector investment with potential investors in civil land remote sensing from space. Many of the private sector attendees indicated that their companies would want to undertake their own market studies, and possibly their own marketing activities, before deciding whether to invest in land remote sensing from space.

NOAA does not contemplate that it will be funded to carry out a market expansion program during the period that it operates the Landsat D system. Instead, we will try to increase the market by providing data on a timely and reliable basis. NOAA will also encourage the development of additional applications of the data.

3. QUESTION: One of the major complaints by many users is the timeliness with which they receive the data. How would you see the system operating in a more effective manner?

ANSWER: The current Landsat 2 and 3 ground system was designed as part of a research and development system. The new Landsat D ground system was designed to ensure more rapid preprocessing of data. The Department has confidence that the design goals for this system of 85% reliability averaged over 10 days will be achieved and that single agency responsibility and management of the end-to-end data flow will assure timely delivery of data once the TDRSS system is fully operational.

4. QUESTION: Could you please discuss in more detail the user conferences you had and what resulted from them, including types of participants, etc?

ANSWER: Five one-day conferences for non-Federal users were held by NOAA in the spring of 1980. Non-Federal users were advised of the planning for a possible future operational system then taking place and were asked for their estimates of the data needs that might shape a future system. In the spring of 1981, NOAA sponsored or co-sponsored an additional five conferences. At these, non-Federal users were informed of the Administration's commitment to an interim operational system based on the Landsat D and

Landsat D' satellites, the new Landsat D ground system under construction at the Goddard Space Flight Center and the EROS Data Center. Participants at the 1981 conferences were asked to provide their views on data product and service priorities for the Landsat D system and on the commercialization of U.S. land remote sensing from space.

Non-Federal attendees at each series were almost equally divided among the state and local government, commercial, and academic sectors. A few attendees represented international or foreign interests and a small number were from the press or special interest groups.

The most significant finding from the conferences was that continuity of Landsat MSS data is the primary concern of end users. The most requested system improvement was more reliable delivery of archived data, with more rapid delivery of these data being the second most requested improvement. State and local government attendees, as well as those from the academic world, voiced concern that planned increases in product prices might reduce or delay their access to Landsat data. In some cases, they speculated that commercial product pricing structures might preclude access for them.

Representatives of commercial interests at these conferences thought that U.S. industry owed it to itself to make a thorough examination of the possibilities for private sector investment in land remote sensing from space. These commercial representatives felt that open discussions between the government and industry would be needed before investment decisions could be made.

5. QUESTION: How might you address the distribution of R&D data to prevent it from undercutting the operational data?

ANSWER: No decision has been made on the future terms of distribution for R&D data. NASA and NOAA are aware of its potential to undercut operational data, and plan during FY 1982 to develop a proposal to prevent undercutting of the operational data.

6. QUESTION: Could you discuss the various pricing options that you are discussing with both domestic and foreign users?

ANSWER: NOAA has prepared a pricing proposal for Landsat D products that is still under review by the Administration. Pricing decisions are expected to be reached during the fall budget process.

7. QUESTION: With regard to pricing policy, how does private sector competition compare with the options you are examining?

ANSWER: The Department has submitted a proposal to the Administration that will begin to recoup operation and maintenance costs starting in FY 1983. A private company would also have to recoup capital investment costs and make a profit, so that its prices would probably be higher than prices to be charged by the government during the initial operation of the Landsat D system.

8. QUESTION: Could the present system including Landsat D and D' be converted to an operational system? What would it take?

ANSWER: The present ground system is being used to process the reduced data flow from the degraded Landsat 2 and 3 and to process the data backlog. It cannot be converted to an operational system in support of Landsat D and D' because it is intermingled with NASA's general data processing system. The new ground system being installed for Landsat D and D' will be used for the NOAA interim operational system. This data processing system is for Landsat only, and will produce MSS data operationally at 85% reliability averaged over 10 days.

9. QUESTION: During the 1982 authorization process the French space agency testified on the SPOT system. They seem to be developing a simpler, less sophisticated system, but one they feel will meet user requirements on an operational basis. Is the U.S. too caught up in ensuring that our system must be the most sophisticated and complex and therefore, costly?

ANSWER: The SPOT system is a sophisticated system. SPOT will use advanced multi-linear array technology to acquire 20-meter multispectral and 10 meter panchromatic data on a repetitive basis. SPOT's sensors will be pointable, and thus may permit some stereo coverage. It is fair to assume that SPOT was designed with these features because the French concluded that SPOT would meet user requirements. However, they may experience difficulties in processing data at the high data rates, resulting from the increased resolution of SPOT's sensors.

The Landsat D system was originally designed as a research and development system, not as an operational commercial system. As a result, both the satellites and the Thematic Mapper, an R&D sensor, are more complex and costly than the SPOT satellite and sensors. However, with the 1980 re-baselining of the Landsat D ground system, MSS data will be provided operationally in early 1983 and TM data by early 1985.

10. QUESTION: Have you considered different types of systems to meet different user needs?

ANSWER: The needs of various classes of actual and potential users, as well as possible alternative systems to meet these needs, were studied in 1980 during the preparation of the Transition Plan for land remote sensing from space. A public document based on the Transition Plan, Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options, Department of Commerce, June 20, 1980, is available to potential private investors that may be considering designing systems to meet different user needs.

11. QUESTION: In your statement you say "one objective /of U.S. involvement/is fulfilling data needs of American users, including the Federal Government." Does this mean maintaining data continuity?

ANSWER: It is expected that Landsat D and D' will provide continuity of data through at least the mid-1980's. In the unlikely event that Landsat D should fail prematurely, Landsat D' will be available as backup. Based on the expressions of interest we have received from various potential private sector investors, we believe that land remote sensing data can be made available commercially and that continuity beyond Landsat D and D' can be provided by the private sector.

12. QUESTION: Is it your experience that foreign nations are using our Landsat data at a much greater rate of growth than domestic users? Why does this appear to be the case?

ANSWER: EROS Data Center data sales to foreign addressees have increased somewhat more rapidly in recent years than sales to U.S. addressees. In addition, the amount of Landsat data acquired by foreign ground stations has increased as the number of ground stations has grown. However, the EROS Data Center figures do not reflect the total amount of Landsat data distributed to Federal users, since 50% of the data have been distributed directly to Federal agencies from the NASA Goddard Space Flight Center. Overall, the Federal Government continues to be the single largest user of Landsat data.

The greater rate of increase by foreign users may be attributable to the growing international awareness of the potential benefits of Landsat data. In addition, some countries may have made large initial bulk purchases of data.

QUESTIONS FOR REPORT ON LAND REMOTE SENSING HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

1. QUESTION: The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.

(a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

ANSWER: No resource areas or types of observations inherently require a dedicated satellite or system of satellites. Technical and cost considerations at this time seriously limit our ability to consider different types of sensors on a single satellite or system of satellites.

For example, land observing sensors in principle can be combined with sensors such as those used on NOAA's polar orbiting environmental satellites. However, the twice daily orbital repeat cycles, the equator crossing time required to provide data for various numerical weather models, and the altitude required for the present generation of polar orbiting weather satellites are incompatible with the orbit required for periodic observation of the land by a sensor such as the Landsat D MSS or TM. Also, the orbit used for the polar orbiting environmental satellites cannot accommodate the weight and power requirements of mechanical sensors such as the Landsat MSS or TM.

While polar orbiting spacecraft could be designed to accommodate both land and weather sensors, the price would be substantial, perhaps running into several hundred million dollars (exclusive of sensors). A new generation of land sensors (multilinear array) would have to be developed and tested to reduce the weight and power requirements of the electro-mechanical sensors, and compromises that might be less than satisfactory would have to be made on orbit selection and equator crossing times for remote sensing of both the land and the atmosphere.

Such a change in satellite operational characteristics would further diverge the civil and military polar orbiting weather satellite systems, thus eliminating the economic benefits now experienced by both programs through the use of common spacecraft. In addition, the operator of such a system would run the risk of losing both sets of sensors in the event that the spacecraft was lost. With different spacecraft the risk is spread. Finally, the useful life of our weather sensors is currently 20 months whereas the Landsat D spacecraft and sensors have an estimated 3 year useful life. If combined on a single spacecraft, the entire craft would have to be replaced when the component with the shortest life failed.

The functions now performed by the GOES satellite could not be combined with land observing sensors. This is because the geostationary orbit required by the GOES satellite and the polar orbit required by land observing satellites are incompatible. It does not appear to be technically feasible to develop the optical systems required to achieve from geostationary orbit the resolution needed for remote sensing of the land. Furthermore, geostationary orbits would provide poor coverage in the higher latitudes, areas of particular importance in remote sensing of renewable resources.

The functions now being performed by the GOES satellites theoretically could be continued by placing GOES sensors on geostationary communications satellites. However, it is not clear whether this approach would be cost-effective. A new generation of weather sensors would have to be developed because GOES are spinning satellites and the communications satellites are not. In addition, a new spacecraft large enough to carry communications equipment and an environmental sensor would have to be developed. Finally, as with the polar satellites, there is a problem of disparate equipment lifetimes. Environmental imaging sensors now have a lifetime of three to five years, while communications equipment lasts seven or more years.

2. QUESTION: Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of LANDSAT system and whether the system should be operational now.

(a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

ANSWER: The current system consists of two spacecraft that have lasted beyond their design lifetime and are now able to support a limited mission only, and a ground system that has evolved from a R&D design. Such a system cannot form the basis of an operational system. The limited amounts of data now gathered are being handled and the backlog of previously acquired data is being reduced, but an operational mission is not being met.

(b) What is the applicability of LANDSAT D to an operational system?

ANSWER: NOAA will begin to manage Landsat D as an operational system after NASA has launched the satellite and fully tested its ground system. NOAA is scheduled to assume operational responsibility for the Multispectral Scanner on Landsat D early in 1983 and for the Thematic Mapper after it has been thoroughly tested, probably in 1985.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

ANSWER: The program will provide a one satellite system with a back-up satellite available on a 90-day call-up through the mid-1980's, and a ground system that meets an 85% confidence standard that all data will be processed and made available within 48 hours of receipt when averaged over 10 days. Users have told us that the planned system will adequately meet their needs.

3. QUESTION: Policy issues relating to the proper government/private sector relationships and the scope of the involvement of the commercial sector are in need of further clarification.

(a) By what process should responsibility for remote sensing move to the private sector?

ANSWER: The Cabinet Council on Commerce and Trade is now reviewing this question to determine the best mechanism for implementing the Administration's policy of transfer of responsibility for land remote sensing to the private sector as soon as possible. We hope to work with the Congress in reaching this decision and in developing any necessary legislation.

QUESTION:

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the question of finances)?

ANSWER: We believe that the private sector can successfully operate both the space and ground segments of an operational land remote sensing satellite system, leaving aside the question of finances. For example, at the present time, contractors are successfully operating nearly all aspects of the Landsat program for NASA.

QUESTION:

(c) Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

ANSWER: As I stated in my testimony, "unless there are compelling reasons to select a different alternative, we favor an approach that will promote competition in the private sector." We also want to encourage competition in both the data acquisition (space) and pre-processing (ground system) segments to the maximum extent possible. The disadvantages of a monopoly here, as in any industrial sector, are the increased likelihood of higher prices, less market responsiveness, and curbs on future industry growth.

QUESTION:

(d) How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

ANSWER: At this time we cannot state with certainty how much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational land system. At least one interested company has indicated that a guaranteed data purchase contract with the Federal government is a prerequisite to its assumption of responsibility for the land system. However, other companies have not requested a government guarantee but instead want assurances that the government will not compete with their efforts. Some companies have requested other forms of financial assistance such as favorable depreciation allowances.

Continued government subsidies to the existing Landsat system would have the effect of diminishing competition and thus inhibiting innovation. For this reason, the Administration has decided that it will not continue to subsidize procurement of land remote sensing satellites after Landsat D and D'.

QUESTION:

(e) Is a copyright provision necessary for private sector operations?

ANSWER: We assume that a private owner of a land remote sensing satellite system will want to have some form of protection for data and products produced by the system. Whether this protection will take the form of copyright or coding or a combination of these two will be up to each private owner. We do not believe any amendments to the copyright laws are necessary to allow protection of data from private systems.

QUESTION:

(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

ANSWER: We believe that the concept of non-discriminatory data access is compatible with private sector involvement because (1) no company with which we have spoken has indicated that this concept is incompatible with private sector involvement; (2) given the large capital investment in land satellites, we expect that a company would want to recoup its investment through sales of data to all buyers; and (3) this concept does not prevent a company from recovering a return on its investment and charging what the market will bear.

This concept is important to ensuring that U.S. foreign policy objectives, including preserving the U.S. "open skies" policy, are met. If the U.S. can tell buyers in foreign countries that they will have non-discriminatory access to data from U.S. land satellite systems, this will not only help the U.S. balance of payments but also may work to preclude the imposition of more restrictive policies for treatment of remote sensing data by the Group of 77 members of the U.N. Committee for Peaceful Users of Outer Space (COPUOS).

QUESTION:

(g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

ANSWER: Our general views on non-discriminatory access to data are stated above. In the absence of domestic legislation establishing the policy of non-discriminatory access, we do not believe that a U.S. landowner would have any right to demand access to data from privately-owned land satellite systems. Although the U.S. is a party to the 1967 Outer Space Treaty (which states the principle in Article I that "the exploration and use of outer space...shall be carried out for the benefit and in the interests of all countries"), the United States position has been that this treaty does not compel nondiscriminatory access by all nations to all land remote sensing data collected from outer space. The Group of 77 disagrees and has pushed in COPUOS for a set of "legal principles on remote sensing" to establish the rights of foreign nations to access data about their territory and natural resources on a priority basis.

QUESTION:

(h) How should a private sector operator be regulated, if at all?

ANSWER: As I stated in my testimony, "some minimal government supervision" of a private sector operator may be necessary to ensure that the U.S. attains its foreign policy objectives, protects its national security and complies with the 1967 Outer Space Treaty. The level of regulation may depend on the degree of competition in the land remote sensing satellite industry. A monopoly would require greater government oversight than a more competitive industry.

QUESTION:

(i) Who should do R&D? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

ANSWER: To maintain U.S. technological leadership in the remote sensing satellite field, the U.S. government should continue its space development and testing of new space technology, even after industry assumes responsibility for operational land remote sensing from space. This is essential in an area such as remote sensing where the high risk nature of proof of concept research places it beyond the reach of private sector financial capabilities. In the case of communication satellites, the U.S. Government did not continue R&D activities after the commercialization of civilian satellites. As a result, U.S. leadership in the communications field slipped markedly and NASA was authorized to re-enter this field of research.

Industry should bear the full costs of sensor refinement, satellite design, and those aspects of applications development and testing that are integral to its marketing program. Government efforts in applications should be restricted to providing advanced technology transfer in areas of public concern, and to those developments required to extract information from the satellite data required by governmental needs.

QUESTION:

(j) How should the sale price for government equipment be determined for a transfer to the private sector?

ANSWER: The Administration is examining this issue at this time and will have recommendations for the Congress later this fall.

QUESTION:

(k) If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

(i) With respect to continuity?
(ii) With respect to technical development?
(iii) With respect to market preparation?

ANSWER:

(i) There is no direct effect on continuity of data from initial government operation of the operational land remote sensing system. The only disadvantage--which would be indirect--arises from the question whether land remote sensing operation by the private sector can be accomplished rapidly enough to permit a private system to be in operation by the time the present system consisting of Landsats D and D' ends with the failure of Landsat D'.

(ii) Initial government operation of the Landsat space segment should represent an advantage to private sector operation in that it permits several years for development of the potentially long lived solid state detector technology required to eliminate the mechanically scanned MSS and TM used on Landsat D. There are no disadvantages to initial operation by the government, provided industry perceives that the government intends to transfer the system to the private sector and to refrain from competing with industry for the data market.

(iii) With respect to market expansion, the private sector has historically been more effective in developing markets for products and services. Thus, initial government operation is an advantage only in that it provides a source of data to existing and potential users of data until the private system can be designed and a marketing effort put in place based on the performance of the private system.

QUESTION:

(1) What would joint ventures between government and businesses contribute to the present system? Is legislation necessary to permit joint ventures?

ANSWER: Joint ventures may have the advantage of increasing operator flexibility in system design and funding arrangements. However, it is impossible to state generally whether joint ventures are preferable to other institutional arrangements. Instead, each joint venture must be evaluated for cost savings and benefits to users. The Administration does not now support a joint venture for future systems that would involve commitments of Federal funds.

Legislation is needed to authorize civil operational land remote sensing from space. No Federal agency now has authority to manage or supervise civil operational land remote sensing satellite systems. Authority to enter into joint ventures could be included in this legislation. In the case of meteorological satellites, some forms of joint ventures are legally possible under the existing broad authorities of the Secretary of Commerce to observe environmental conditions and forecast the weather.

4. QUESTION: Universities are currently involved in research and training in the area of remote sensing.

(a) How is the contribution of universities important?

ANSWER: First, universities train young people who will do remote sensing research, who will operate and manage future remote sensing systems and who will use remotely sensed data products. Universities also are sources of information and specialized experience for solving remote sensing problems. The basic research conducted at universities leads not just to new discoveries; along the way, it produces the measurements and theories for technical advances.

(b) What should be the role of universities in the future, i.e. if we have an operational system? What should be the role of the Federal government vis-a-vis universities?

ANSWER: The role of universities in remote sensing should not change with the advent of an operational Landsat D system. Remote sensing education and research will continue to be done by universities. Within budget constraints, Federal contracts with universities should be continued, to provide training courses for remote sensing, to conduct studies for Federal projects, and to support basic research in remote sensing areas.

(c) How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

ANSWER: With commercialization, remote sensing data will become more expensive, and universities will need additional funds to meet these expenses. Some new applications techniques or other advances made by the private sector may not be as readily shared with university experts. On the other hand, a growing remote sensing industry would provide more work for graduates of university remote sensing programs. In addition, industry might become convinced that steady support to universities in the field of remote sensing, is in its best interest, as has happened in the computer science field.

5. QUESTION: Satellite data is being utilized to provide data for public services.

(a) How is the utilization of remote sensing data important to the public welfare and health?

ANSWER: Public agencies at all levels of government are concerned with accomplishing their mandates cost-effectively. Agencies that have used remote sensing data have had management responsibilities for natural resources and the environment, such as developing water resources, overseeing petroleum extraction and mining, maintaining transportation networks, managing air and water quality, and executing emergency preparedness procedures.

Remote sensing data allow experienced observers to assess conditions more rapidly, and at less cost per unit area, than conducting surveys on the ground. Aerial photography is used where surface detail is required and/or small areas are being inventoried. The value of Landsat and future land remote sensing satellites to public services is that very large areas can be observed with a consistent data format on a regular schedule and at less cost than with other methods of inventory and assessment.

QUESTION:

(b) To what extent are State and local governments utilizing this data for public services?

ANSWER: State governments and, to a lesser extent, local governments are using these data in much the same way and for the same reasons as the Federal government. State use is lower than Federal use primarily because state budgets generally permit less experimentation with new technology. The report, A Survey of State Applications of, and Investments in, Landsat Technology, prepared by the National Conference of State Legislatures and the Council of State Planning Agencies documents the extent of state use as of May 1981. The report concludes that state use of these data has expanded significantly since 1978. The use of Landsat technology is associated with the increased use of computer technology and of geographic information systems in the states.

QUESTION:

(c) What are the primary concerns of the State governments (i) with the system as it would be if Landsat D (and then D') were run by NOAA as they are now running Landsat 2 and 3?* (ii) with the future commercialization of land remote sensing?

ANSWER: The states have indicated in Congressional testimony and in various reports that they require a reliable consistent source of data regardless of who operates the system, and that they are sensitive to price changes especially without sufficient advance notice. States are also concerned whether the private sector will be as responsive to their needs as the Federal government has been. State and local governments have information needs in common with the Federal government yet constitute a relatively small part of the total user market.

NOAA's plans for management of the Landsat D system emphasize reliability and timeliness of data delivery to users. Price changes will reflect operation and maintenance costs and will be announced as far in advance as possible. State and local government representatives will be included on the Land Remote Sensing Satellite Advisory Committee to assure that the views of these groups are taken into account throughout the period of NOAA management and planning for commercialization.

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* NASA is running Landsat 2 and 3.

6. QUESTION: There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop.

(a) Is present data receipt and handling centralized? What are the advantages and disadvantages?

(b) Could a new system (i.e. new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

ANSWER: (a) Both the present Landsat 2 and 3 system and the new Landsat D system are a combination of centralized and decentralized data receipt and handling. All data destined for the U.S. archive and users obtaining data through the EROS Data Center (EDC) arrive at Goddard Space Flight Center and are preprocessed on a single system (part of which is at EDC). On the other hand, ten foreign ground stations now receive and process regional data received by direct broadcast from Landsat. No foreign ground station is currently equipped to receive Thematic Mapper data from Landsat D but several are planning to modify their stations to do so.

The advantage of this mix is that the U.S. can obtain data from any part of the world (through the use of tape recorders on Landsats 1,2, and 3 and via TDRSS for Landsat D and D') while foreign users served by foreign ground stations have local access to data from a nearby source. The chief disadvantage is that cost recovery is complicated for data received by foreign ground stations. NOAA is currently studying pricing schemes which can overcome this disadvantage.

(b) Fully distributed data receipt and handling would require an augmented network of ground stations throughout the entire world since current ground stations do not permit data recovery over a large portion of the earth's land surface. Furthermore, processing of the data from such sophisticated sensors as the Thematic Mapper requires expensive computer systems which would have to be duplicated throughout the world for fully decentralized data handling. The cost disadvantages of a fully distributed system offsets the advantage of local access. An additional disadvantage of decentralized data handling would be the difficulty of providing uniform products from all data processing systems.

The early months of Landsat D operation will involve a quasi-decentralized mode of operation whereby tape recorders will be installed in approximately five foreign ground stations to acquire MSS data only from Landsat D until the TDRSS achieves operational status. The disadvantages of this mode of operation are that many areas of the world will not be accessible through foreign ground stations so that MSS data on these areas will not be available. In addition, MSS data availability in the U.S. will be delayed for about two weeks to allow shipment of tapes to the U.S.

7. QUESTION: There is a need to clarify how remote sensing data could or should be priced.

(a) For a government-operated system, should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

(b) If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?

ANSWER: The Department has developed a pricing proposal for products and services from the Landsat D system that is now under Administration review. The proposal is designed to recoup the costs of operating and maintaining the system, starting in FY 1983. No decision has been made on amortizing sunken costs for hardware or development.

QUESTION:

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

ANSWER: Current national policies prescribe that data prices should be consistent between similar classes of users, and that data must be made available to the public on a nondiscriminatory basis. Apart from these specific subject areas, government intervention in the activities of the private sector should be kept to a minimum. We do not contemplate government ratemaking when the private sector takes over.

8. QUESTION: The following questions do not have to be considered LANDSAT specific, but can be viewed as pertaining to remote sensing from space in general.

(a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

ANSWER: The Federal government has provided over a decade of development, demonstration and operation of land remote sensing from space. This substantial investment has generated sufficient information to allow prospective private sector investors to evaluate whether land remote sensing is commercially valuable.

QUESTION:

(b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

ANSWER: The first major policy decision was to move from an experimental land remote sensing system to an operational system based on the Landsat D satellites. As a result of that decision, the MSS ground system was re-baselined to provide 85% reliability of data averaged over 10 days. Thus, the Landsat D system has both an operational sensor, the MSS, and an operational MSS ground system. Decisions with respect to the operational status of the Thematic Mapper will be made by 1985.

The second major decision was to transfer responsibility for land remote sensing to the private sector as soon as possible. The implementation of that decision is now being considered by the Administration and recommendations will be made to the Congress later this fall.

Senator SCHMITT. Thank you, Mr. Wright. Mr. Beggs?

Mr. BEGGS. Thank you, Mr. Chairman. I just have a few comments I would like to make. First of all, NASA is heartily in accord with the idea of moving this into the private sector. Logically, it is the way to go once it has been determined that a market has developed that would support the economic activity involved. It is also likely that doing so will put this Nation in a far more competitive posture.

Second, if legislation is to be drafted, as it has been in the past, it should be as flexible as possible. Having spent most of my life in the business world, I am deeply aware of the problems of bringing in a new commercial venture which may require financing at a time when a fair amount of risk is involved in the area of market development.

I would urge a fairly permissive, flexible, innovative statute that would permit any number of different alternatives for private sector entry. It should provide permisssion to sell, donate, or share the Federal Landsat assets. It should provide permission, as Mr. Wright has stated, to engage in either joint ventures, licensing, or possibly giving authority to have a monopoly position for a period of time. And it should waive the necessary antitrust freedom of information and copyright provisions for some period of time.

We think that this venture can be successful and I think that there is a market there. Whether the market can sustain a viable commercial venture at this time, I cannot judge. But we would certainly be pleased to work with you during the next several months in drawing up that necessary legislation. Thank you.

Senator SCHMITT. Thank you, Mr. Beggs. Gentlemen, we have a traditional rule that we go for 5 minutes of questioning in the order of arrival. That is to penalize those who arrive late.

As Chairman, I'm being penalized.

So as I understand the order of arrival, who was here first?

Representative FLIPPO. I suppose I was here first, but Mr. Chairman, we would be delighted to follow whatever rule you suggest.

Senator SCHMITT. The 5-minute rule, and I yield to my distinguished House colleague.

Representative FLIPPO. Mr. Wright, thank you very much for your statement, and Mr. Beggs, I appreciate that. I noted with interest that in your testimony on page 1, Mr. Wright, the President's fiscal year 1982 budget recommends that the Secretary of Commerce operate an interim operational system. I believe the budget contains some $2.1 million for that function.

I'd like to ask if you think that that is enough money to operate a system. Perhaps you could shed some light on how long a period is an interim period of time.

Mr. WRIGHT. Yes, sir. I'd be more than happy to. The plan in the fiscal 1982 budget for the Department of Commerce is primarily for the planning and setting up of mechanisms to be able to pick up the operational responsibilities of NASA. From that standpoint, yes, I do believe that that is sufficient to accomplish that responsibility. The fiscal 1983 requirement, in my understanding, is $36 million. At that stage we're talking about operating Landsat D. And I do feel that that is also sufficient in order to prove the worth of the system from a commercial, as well as a Government point of view.

Now to go beyond, I have to say that I really don't know. We have to get that stage before we find out whether or not we really do have a commercial venture here, one that can be picked up by the private sector successfully, that can be an ongoing, profitable venture, and how the transition would take place.

But I do feel that the budget is sufficient.

Representative FLIPPO. The points that you made about what we're really talking about is transferring financial responsibility, almost. I guess that technology seems to have a way of transferring almost by osmosis. What we're talking about is transferring financial responsibility and this may be part of the bigger picture—how it will leave Government transfer, how do we pass the baton to the private sector on research and development.

Since we are really talking about a financial decision, part of the consideration is recovery of cost. As you mention on page 4, that proposal is designed to recoup the cost of the system starting in fiscal year 1983. Under what cost do you have in mind there? Are you talking about resulting cost? Are you talking about hardware cost? because that would play an important part in the financial considerations.

Mr. WRIGHT. It's my understanding, Congressman, that this is ongoing operational cost. It is not the original development and hardware cost.

Representative FLIPPO. On page 5, you say that the Department is on schedule in assuming the responsibility for the interim operational assistance. What is that schedule? Do you have a specific schedule for assuming the responsibility for the interim operational system? Or do you have a schedule that you could present for the record, perhaps.

Mr. WRIGHT. Yes, sir. I'd be more than happy to.

[The information follows:]

Schedule of Activities Leading to Operation of Landsat D by NOAA

1. Authorizing Legislation

A short bill authorizing the Secretary of Commerce "...to plan and provide for the management and operation of a civil land remote sensing satellite system..." was sent to the Congress on May 5, 1981. A comprehensive bill is under consideration by the Administration.

2. Coordination Mechanisms

The Secretary of Commerce has approved charters for the Program Board for coordination of the land remote sensing satellite system within the Federal government (June 14, 1981) and a Landsat Advisory Committee for coordination with the non-Federal sector (July 14, 1981).

3. Memoranda of Understanding

Memoranda of Understanding (MOU) with entities responsible for various portions of the Landsat operating system are under preparation. One with NASA for spacecraft, launch, and preprocessing is scheduled for completion 1Q CY 82.* The agreement with the Department of the Interior's EROS Data Center (EDC) is to be completed in 4Q CY 81. The MOUs with the various foreign ground stations will be negotiated during 1982, to be effective in 1Q CY 83 when NOAA takes over responsibility for operating the MSS on Landsat D.

4. Initial Fee and Price Schedule

A proposed price schedule for Landsat D MSS data and products was presented to Federal agencies on May 27, 1981. Further review is continuing within the Executive Branch. The new prices will be announced before the end of CY 81. Thematic Mapper data will become operational circa 1985.

5. Operations Staffing

Currently, five persons have been detailed full time to the Landsat Operations Group. This group is charged with preparation for the day-to-day operational management of the Landsat D system after NOAA assumes this responsibility from NASA in 1Q CY 83. Actions are underway to select those to be transferred to this activity and to increase the staff to ten people by the end of this year. Eight will be located at GSFC and two at EDC. All personnel will be active in the checkout phase of Landsat D and its ground system, and ready to assume full operational responsibility in 1Q CY 83.

6. Procurements

Two major procurements are needed for NOAA to operate the Landsat system. Both are underway. They consist of the contracts to maintain and operate the ground system segment located at GSFC and to install high density tape recorders in additional foreign ground stations. The tape recorders are needed to complete a network established by NASA for data collection pending the availability of the NASA TDRSS. Both of these procurements are scheduled to be completed for operations by 1Q CY 83.

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*First quarter of calendar year 1982.

Mr. Wright. I believe I referred to that very briefly on page 2, where I said near the bottom of the page:

> We expect to assume operational responsibility for the Multispectral Scanner on Landsat-D early in 1983 and for the Thematic Mapper around 1985.

I'll be more than happy to submit a detailed schedule.

Representative Flippo. Thank you, Mr. Chairman.

Senator Schmitt. Thank you. Congressman McGrath?

Representative McGrath. Thank you, Mr. Chairman. I'm kind of excited about the possibilities of transferring our operation to private enterprise. But I'm concerned about a couple of things. No. 1, the timing of that transfer. Are we in good enough shape technologically to transfer to private enterprise now those functions in the R. & D. that we presently have in NOAA and NASA?

Mr. Wright. Let me answer for the Department of Commerce and NOAA for a second and then I'll yield to my colleague on NASA. I believe you have to divide it out into two pieces; that is, the research and development aspect that NASA has, including the construction of satellites and launchings, and the operational responsibility.

I believe that we could be in shape within the next several years to transfer on a gradual basis the responsibilities to the private sector if it's well planned out and there is a good—if you want to call it cost/benefit ratio that is established that provides the private sector with the incentive to have the profitability to be able to run it.

There are very serious concerns as to whether or not research and development can be transferred in the same timeframe. But I will yield to my colleague.

Mr. Beggs. My view is that most of the technology is well developed, although, obviously, we are still learning or we wouldn't be flying Landsat D and D′. There is always an element of risk and the element of risk involved in transfer to the private sector would be the ultimate result of how well that technology translates into a usable, marketable system. This is always true in any commercial venture, no matter what kind of new product is being developed.

We believe that by 1985 Landsat D and D′ will clearly be to the point where it will be commercially viable. Our foreign counterparts also seem to believe that because both the French and the Japanese are moving ahead and are advertising that they will soon be ready to sell data.

So, I think the current state-of-the-art is clearly within a range of risks that a commercial venture could accept. Again, the other part of that question is how the commercial venture would assess the market and how fast the market is going to grow.

Represenative McGrath. We're going to have competition among other nations, the same people.

Mr. Beggs. Yes.

Representative McGrath. The other concern is that the Government, having done the R. & D., having been in the operational phase, having launched the satellites in the past, are now giving away—not giving away. Hopefully, not giving away—some of the responsibility and the technology which we have developed. I'm concerned about the type of deal that the Government is going to get.

Let me establish somewhat of a scenario for you and see if you will agree with it. Either by competition or sole-source procurement, some company would come along and make a proposal to buy NASA and NOAA ground station satellites and whatever, and operate them on a basis of perhaps a cost-plus basis, selling back to the Government the information which the Government needs and then selling to whomever else the information which they need.

Now who do you envision would assess—first of all, am I right?

Mr. BEGGS. I think so.

Representative MCGRATH. OK. Who would assess the value of the NASA-NOAA equipment, ground stations, and whatever, at this point? And how would it be done? How would you see in your mind that that could be done equitably?

Mr. BEGGS. There is, as you know, a book value for those assets.

Representative MCGRATH. Any depreciation?

Mr. BEGGS. We don't depreciate things. But certainly, we can assess a present value. That's a relatively easy calculation to make. However, it may be that in order to get a competitive enterprise, or several competitive enterprises, as my colleague has suggested, one of the alternatives would be to discount those assets. We've done that in the past in getting new ventures started.

That's why I stated in the few remarks I previously made, that any legislative base you create for the establishment of the commercial venture should be flexible enough to accommodate a structure which allows a new enterprise to be viable when it begins. If you don't do that, it's simply going to go bankrupt. It cannot sustain the financial flow that the need.

Senator SCHMITT. We'll go another round here. Congressman Nelson?

Representative NELSON. Good morning. Mr. Wright, we have international agreements pertaining to the free exchange of weather data. What data would the private sector have to provide to meet those agreements, and in what volume?

Mr. WRIGHT. Congressman, right now the weather data is freely exchanged through the U.N. World Meteorological Organization global telecommunications system. Over 150 nations are participating in that. These are long-standing international agreements. We have to understand if there's any remand to the private sector on land remote sensing that includes weather, that these agreements will be affected. That's one of the concerns of the Department of Commerce.

It would be much easier to separate out and remote sensing satellites in terms of transferring the system to the private sector to begin with and monitoring how that works as a profitmaking venture for the private sector, rather than combining to start with.

Representative NELSON. Do you see a phase-in period, then, for the transfer of that information by the private sector?

Mr. WRIGHT. Yes, sir. At this time, it seems to make sense to get it out of the international political arena.

Representative NELSON. And you're confident that the private sector could handle that?

Mr. WRIGHT. In the sessions that we've had so far with the private sector, they have shown a serious interest, even to the extent of coming up with the draft proposals. I am not confident that the financials that we have discussed have been properly evaluated and there is a lot of work yet to be done on that.

I have to say I don't know whether or not there is enough volume of demand in the private sector to support just strictly the land remote sensing. But I believe that we should look at land sensing seriously as an entity by itself to begin with. To put land sensing together with weather reporting is going to get us into an international political situation that could be a little tough.

Representative NELSON. Mr. Beggs, if I may, NASA is an R. & D. agency in the Landsat program. It's been experimental. And thus, by this experimental program it has precluded a buildup of a solid market.

Now is it possible that there is going to have to be a period of stable operations to let the user community build up this solid market?

Mr. BEGGS. I think that question is very difficult to answer because what you're trying to attract is entrepreneurial kind of activity. I think it depends largely on whether you can find some entrepreneurs in this area who can see a way. You know, their job is to develop a market. Their function in our economy is to take ideas or research and development and translate it into marketable products and thus, in effect, create the market. If we're going to pursue the private sector involvement, I think we ought to look for some entrepreneurial activity that will go out and create the market. Clearly, there's a market now and that market, as my colleague has said, must be served. We have international agreements as well as domestic requirements. We have been supplying data to local and state governments as well as a number of private operators who use the data for a wide variety of purposes.

The question that one asks oneself is: "Whether the current market base in sufficient to sustain a commercial enterprise?" My opinion at this time, is that it probably is not.

Representative NELSON. How long do you think it would take to establish that market?

Mr. BEGGS. The more data one has and the wider the dissemination of that data, the faster that market is going to be developed. In 1983, when we will have checked out the Multispectral Scanner on Landsat-D, and in 1985, when we will have achieved operational status with the Thematic Mapper on Landsat-D, we will be providing data which should be more valuable than that which we are providing today.

Therefore, one can assume that the market will develop more rapidly when there is a wider spectrum of data. I would say that any business involves a lot of luck. The old adage is that I'd rather have luck than smarts. If the data we provide turns out to be very valuable, as it conceivably could, the market could come along overnight.

Representative NELSON. Thank you, Mr. Chairman.

Senator SCHMITT. Thank you, Congressman. I think we'd better separate out the components of the problem. No. 1, I don't think there's any disagreement any longer that there's legitimate role for research and technology for the Government and NASA in particular in remote sensing technologies. It's the same situation that developed in communications and other areas where we tried to get out of it and we found that we shouldn't have abandoned the long-term, sustained research and technology. I doubt if there's very much disagreement among the people here or anybody that that's a legitimate role for NASA. In fact, that's the basis role that you've had so far in the remote sensing area.

Second, there is something that I have called, and I think most people call the provision of raw and preprocessed data.

Third, there is the provision of value-added data. In the value-added area, I don't think there is any, or I have not heard of any, disagreement that that not only can be, but is already becoming a competitive, free enterprise industry, that is people taking Landsat information, aircraft information, a variety of other types of information, processing that in order to provide a value-added data base both for internal corporate operations as well as external private and public uses.

So it seems to me that the thing we're really discussing is what entity exists, operational entity, to provide raw and preprocessed data to this competitive, value-added industry.

The issue that we've had with the Carter administration was whether that should be a governmental entity or a private entity or entities.

Now the Comsat experience would suggest that at least the first stage of providing that raw and preprocessed data could well be a single, privately based entity. But that with time, there would be that inclusion of other entities providing similiar kinds of services, and that one should not preclude that. But at the first stage, in order to be sure that you really can create the market, that the market is there, maybe a smaller step is reasonable.

That's part of the function of these hearings and other deliberations, is to determine that fact. Gentlemen, would you agree that I separated those three components out, that our discussion should involve how do we handle each one of them?

Mr. Beggs. Absolutely. That's a good analysis.

Mr. Wright. I agree, Mr. Chairman.

Senator Schmitt. How with respect to what is included in raw and preprocessed data, it would seem to me that we ought to leave that issue open, whether it includes weather data or not. I agree with Mr. Wright, that part of that will be an economic consideration. But I don't see any a priori reason why the provision of the basic raw data to the weather service and through international agreements with other entities could not be provided through a private entity just as well as it could through a governmental entity.

Mr. Wright, is there any a priori reason why we can't do that?

Mr. Wright. No, Mr. Chairman, there is not, but that would have to be a very clearly understood part of the arrangement with the private sector.

Senator Schmitt. Yes.

Mr. Wright. And you're also asking that at that time the private sector pick up the responsibility for the international agreements. I think that can be done.

Senator Schmitt. We've done it before. Comsat had that responsibility.

Representative McGrath. That's right; it has been done before.

Senator SCHMITT. Do you know the cost of operating the weather system, at least the portion of it that provides raw and preprocessed data to the weather service?

Mr. WRIGHT. Just 1 second.

Senator SCHMITT. You could provide that for the record.

Mr. WRIGHT. It's a little more than $100 million a year, Mr. Chairman.

Senator SCHMITT. So that's sort of a ballpark figure of what, if there was a corporate entity of some kind that took over the operation of the satellite, the gathering as well as the preprocessing system. That would be the value that you might put on the information that it would provide to the weather service?

Mr. WRIGHT. Minimum value.

Senator SCHMITT. Congressman Flippo? Oh, excuse me, Mr. Lowery. You weren't here when we re-established the subcommittees' ground rules: questions are asked in order of appearance.

Representative LOWERY. Mr. Wright and Mr. Beggs talked about further study being necessary. What would you see as the scope of that study and completed over what time frame?

Mr. BEGGS. Mr. Lowery, are you addressing the question of legislation?

Representative LOWERY. Recommendations to us so that the Congress can move on this.

Mr. BEGGS. I would say another 3 or 4 months.

Representative LOWERY. That you will have further recommendations to us.

Mr. BEGGS. By that time, I would think so. I'm only a participant in that particular deliberation, but I think that we could come up with some recommendations by that time.

Mr. WRIGHT. Under your theory, then, Mr. Congressman, right now we really have analysis of alternatives that we have submitted to the Office of Management and Budget and have now submitted back out for the inter-agency review. So I would say that that time frame is rational.

Representative LOWERY. Three or 4 months, thank you.

Senator SCHMITT. Mr. Congressman?

Representative FLIPPO. Thank you, Mr. Chairman. I did have one or two more questions that I wanted to be sure to ask. The board that you have established, Mr. Wright, to assist the administration, the Program Board of Federal Officials that you have established to assist in approaching this transfer, does the private sector have any input into that board? Since the private sector appears to be where we're trying to go with, I'm curious if the private sector has any input into the board?

Mr. WRIGHT. No, Congressman, the private sector doesn't have any input into what you're calling the Program Board for Civil Land Remote Sensing Systems base. That is an inter-agency coordinated board.

What we're done on the private sector side was set up the 15-member land remote sensing satellite advisory committee. That is for the private sector. We're getting advice not only in the interim, but also longer term in terms of the transfer to the private sector. The two of them are separate.

Representative FLIPPO. Would you agree that what we're really talking about here is the transfer of financial responsibility rather than the technology?

Mr. WRIGHT. Yes, sir, I would, but I wouldn't limit it to just financial because, as I mentioned, one of the objectives we have is to make sure of the needs of all the users for this information are met through this transfer, including the Federal Government. If it gets beyond land sensing, we have international agreements that we have to protest. I think that those can be done, but it's more than financial.

Representative FLIPPO. Since you mentioned the study, is there a study going on to assess the Federal needs?

Mr. WRIGHT. Yes, sir, that's one of the purposes for the interagency committee right there. As part of the proposals that we're submitting to OMB, we're going to be continually trying to develop exactly what these needs are. These needs kind of change every once in awhile as you alter the pricing structure. I believe when we come up with our pricing structure, we'll get a much better feeling.

Representative FLIPPO. The major consideration of the private sector taking this over is the financial decision and how well developed the marketing is. If there's a market for weather information, it might be more highly developed than the market for Landsat information. Would you agree to that?

Mr. WRIGHT. I would certainly agree, Mr. Congressmen, except for one problem; that is whether the data has traditionally been transferred free of charge between countries.

So I don't believe there is any question of the value that is provided, of the dollar value or what it would be worth on a charge basis, but the implications of trying to institute those charges across the world, except to special interests, would be rather serious.

Representative FLIPPO. It appears that any service that is free, there appears to be an unlimited demand for that service.

Has the Department given any consideration to purchase that information that is demended at the present time, but to put a cap on that and turn it over to the private sector beyond that factor and let them market perhaps information that may have other characteristics to receive it—sexier weather information, if you will?

Mr. WRIGHT. Yes; we have given consideration to that, not to the extent of what you're talking about, in considering the proposal for this transfer. But let me give you one example and that is part of the Department's budget for NOAA. We included for 1982 the transfer of what we call the "fruit frost" program, back to the private sector on a charge basis. If you've not been involved in the political discussion on that one, which is a very specialized, specialized use, I invite you to look at the record. It is not easy to transfer these funds. But I believe it should be looked at very seriously.

Representative FLIPPO. Thank you very much, Mr. Chairman. We have a vote on the House floor and we have about 15 minutes to answer that call.

Senator SCHMITT. Would you like us to recess and wait for your return?

Representative FLIPPO. I would be pleased for the Chairman to continue, if he would like.

Senator SCHMITT. We'll certainly hold the next panel until your return. Are there other questions for this panel?

Representative NELSON. May I ask a quick question?

Senator SCHMITT. Sure. Yes, please go ahead. It's your judgment. We can ask them to stay for 15 or 20 minutes until you return.

Representative NELSON. I want to ask Mr. Wright: Should a private sector be allowed to make forecasts or storm warnings? And what happens with regard to liability if they make a bad weather forecast, an incorrect weather forecast?

Mr. WRIGHT. Congressman, I don't know the legal ramifications of an incorrect weather forecast. I can't directly answer your question. I would suppose that they would have to indemnify themselves in some way against possible lawsuits because there's no question that if that would come in, that would be a problem. But I can't answer your question very directly.

Representative NELSON. I wanted to stimulate your thinking about this, the question of profit versus service. May not that then go over to a possible solution, if the Government would finish the space data, but then the private sector would receive that data, manage it, and use that as the base from which private enterprise would make a profit?

Mr. WRIGHT. Yes, sir. As the chairman mentioned, I think that the process really should be divided up into its component parts. And it's going to make it much easier to go in and look at, not only what the value is, but how you might be able to structure the private sector-government relationship.

What you bring up is an interesting point because if we would stay with the Landsat and land remote sensing data, that does not involve the safety of lives, and weather service does.

Senator SCHMITT. I'll just follow up briefly on that. I think the important thing is that there is a distinction between the raw data, for which there should be no liability that I can conceive of in the gathering, and the value-added data, which would be the forecast. In those kinds of situations, that would be one of the considerations of whether the Government should not maintain, because of the liability questions, the responsibility for providing that particular type of value-added data.

Now certainly, there are other types of value-added data where I would think that the liability would be minimal or certainly would be handled in normal fashion within the system of commerce.

What is the probability of having an operational Landsat system for the next few years? The budget decision in March was not to fund follow-on Landsat's beyond D′. The Landsat's we have are somewhat vulnerable, particularly in the tape recorder area. Is this an academic discussion about a short-term operational remote sensing system?

Mr. BEGGS. I don't believe so, Mr. Chairman. I think with Landsat D and D′, you could have an operational system. As I said before, there are some risks, as you are well aware. But, I think that if you want to declare that operational once it applies, then it would be operational. But, the key question is: "Whether you can get a private entity to assume it at that point, and whether the system would be of sufficient value to go to the financial markets?" That is where private entities would have to go to raise capital.

Senator SCHMITT. It's my understanding that at least one entity has already made an offer.

Mr. BEGGS. That's true. It is a qualified offer, or rather an offer to make an offer. I think there are others who are looking seriously at it as well.

So, there are some interested folks who seem to be willing to put their money where their mouths are. That's always encouraging. You always have to assess, however, the conditions and sometimes, when you get from the point of early discussions to the point of formal proposals, things change. But that should be pursued, I think.

Senator SCHMITT. I would have to say that it's been my impression that the private sector has been far more bullish on the potential of commercial remote sensing, both preprocessed and value added, than has the Government in terms of one that has been reluctant to take the step.

Mr. BEGGS. That's true, Mr. Chairman. However, as I say, we have not seen a formal proposal. I believe you would want us to wait until we could study a formal proposal to find out whether we really have something that's both financially viable and something that can be accommodated, within, as my colleague said, all the various commitments that have been made around the world and in this country for the delivery of data.

If it can be accommodated, and I think that there is a strong potential that it can, then it should be pursued. I think we ought to pursue the ones that are interested now.

Senator SCHMITT. Well, you're saying that you feel the Government ought to encourage proposals. Really, we never encouraged the private sector to specifically make proposals.

Mr. BEGGS. That's correct. We do not yet have the legislative statutory base to do that, but I think that within what authority we do have, we ought to encourage them to come forward with formal proposals.

Senator SCHMITT. Since there seems to be a growing feeling that probably a transfer of operating responsibility to the private sector should be formulated, why should we make an interim transfer from NASA to NOAA? Mr. Wright?

Mr. WRIGHT. I believe this gets into the division of responsibility between the two agencies, Mr. Chairman, and that is where NASA has traditionally been, as I understand, a scientific R. & D. agency with the construction of the satellites and the launching, and NOAA, on the other hand, has got a little over 20 years in terms of operational responsibilities for satellites and their use to transfer the information.

Senator SCHMITT. Yes, but we didn't transfer communications to NOAA before we created Comsat.

Mr. WRIGHT. It would not have to be done that way. I think what you're doing is you're just taking advantages of the experiences of the specialties of the two agencies. But it would not have to be that way.

Senator SCHMITT. But it just would seem to some of us to be an unnecessary complication if we really are now going to be permitted to find some more efficient mechanism or some mechanism for an operational system. Some of us believe that as long as the Government keeps its paws on remote sensing, that there will not be an operational system that really qualifies for that designation.

Do you think that the Government has a responsibility to maintain data continuity now, as well as in the future, so long as it owns and, in a sense, operates the satellites?

Mr. BEGGS. Yes, I do, Mr. Chairman.

Senator SCHMITT. Well, let's assume that suddenly, for some reason, Landsat was unable to provide that data continuity. Should there be a crash program to get another Landsat up, or should we find the means to make comparable data available from other sources?

Mr. BEGGS. As you're well aware, there are other sources of remotely sensed data, such as high altitude aircraft. Should administration policy so dictate, we could implement an accelerated program to acquire and launch a Landsat-type system to minimize the gap in continuity.

Senator SCHMITT. You think, then, in the interim, let's assume that we did find the mechanism for the raw and preprocessed data gathering assets to be transferred to the private sector. What provisions, in the interim, should we make for emergency provision of comparable data from other sources?

Mr. BEGGS. Currently, there is no other method of acquiring data comparable to Landsat. The spectral and synoptic data requirements of current Landsat data users could not be met by any existing system. The only alternative would be to enter into an accelerated acquisition process for a comparable system.

But I think it may be desirable to assure the market of data continuity, and that should be carefully structured so as not to proceed to a point where you are competing with your commercial entity with free data or with below-cost data.

Senator SCHMITT. Certainly. But have there been any conversations with the Department of Defense as yet on whether such a back-up or emergency provision would be possible?

Mr. BEGGS. Not to my knowledge, Mr. Chairman.

Senator SCHMITT. Would it be reasonable to assume that such conversations would occur before there is a proposal made to the Congress?

Mr. BEGGS. Yes, sir.

Senator SCHMITT. Now, we seem to see on the foreign scene far greater enthusiasm for the availability of operational data than we may have seen domestically. At least that's the impression that one would gather. I'm not sure it's a true impression, but it still is there. The French and the Japanese are moving forward. There certainly is a demand for Landsat data abroad.

Why is this? Do you think that there is any message here that we ought to be aware of?

Mr. WRIGHT. Mr. Chairman, I believe that they obviously see a commercial venture involvement. I believe the message that we should look upon is that we have to take a look very closely at the market place. I believe we have the leadership position from a technology standpoint, as well as an operational standpoint, and we ought to be very careful whether or not we let that slip.

I think that that should be one of the main considerations—not one of the main ones—but one of the serious considerations we have in the transfer to the private sector. What would be the value lost in us losing our leadership position?

Senator SCHMITT. Well, we are losing that leadership position by doing nothing of significance over the last few years in this area.

Mr. BEGGS. May I make a comment, Mr. Chairman? Generally speaking, the Europeans and the Japanese are far more willing than we to subsidize new technology to bring it to commercial reality. The French, for example, have for many, many years very heavily subsidized the construction of commercial transports in the aircraft world. They are, in my judgment, moving into an area where they consider the technology to have far-reaching commercial consequences, and will, if necessary, subsidize it until the time that it becomes profitable. I believe the Japanese are entering on the same basis.

We have traditionally, and I think properly, tended to move in the direction of an entrepreneurial approach. I think that that's a proper way because we've proven over a period of time that we can be extremely competitive in all of these areas when we work together in a very cooperative relationship, as we have had with the aircraft industry over the years, between the NASA establishment and the aircraft manufacturers. I think we can do it this time. But, it is an era of 20 percent interest rates. I'm acutely aware that new commercial ventures are tough. And, this one will be tough.

Senator SCHMITT. Well, that's just one of the roadblocks that we have put in front of our competitive industry in competing abroad with subsidized activities. Where those roadblocks have been minimal or nonexistent, obviously, we've been able to compete very well.

One of the problems, of course, that the aeronautics industry faces is that NASA is continually pulled back from its longer term investments in research and technology in aeronautics. There is obviously considerable going on, but I have had for years complaints from the aircraft industry that it's nothing like it used to be. There's not nearly that sustained flow of new ideas and new technologies that we were used to having.

Some of the new aircraft are putting in some new ideas, but they still are 10-year-old ideas. The question is 10 years from now are there going to be some new ideas moving into that industry that will maintain competitiveness? That's been the NACA role in NASA.

Mr. BEGGS. I believe so.

Senator SCHMITT. I'm not sure that we're maintaining that at the level that matches the competition.

Mr. BEGGS. Mr. Chairman, there are still a lot of good ideas, but I do share your concern.

Senator SCHMITT. And the issue here is whether we're going to maintain an R. & T. base for remote sensing, however we decide to create an operational system. As I indicated earlier, I think that that goes without saying that it must be there. We should have learned our lesson. We should do nothing that would eliminate or emasculate that R. & T. effort. That doesn't mean that the industry won't have a responsibility to carry on their own shorter term technological development. But when you look at the long-term, it has obviously been a fruitful role for the Federal Government, one in which industry and academia generally have supported. And obviously, it will be fruitful in other areas.

Gentlemen, I think we'd better move on. We will have questions for the record on this subject that I hope will stimulate your thoughts as we develop the policy and we'll have many other opportunities to interact on this.

Mr. WRIGHT. Thank you, Mr. Chairman.

[Answers to questions asked of Mr. Beggs by Senator Schmitt and Chairman Flippo follow:]

Responses to Written Questions from Senator Schmitt Resulting from the July 22, 1981, Joint Hearing before the Senate Subcommittee on Science, Technology and Space and the House Subcommittee on Space Science and Applications at which Mr. Beggs testified.

QUESTION E-1:

One of the major components in expanding the market for earth resources information is marketing in both the private and public sectors. What ideas do you have for handling the marketing of data?

ANSWER E-1:

"Marketing" of satellite land remote sensing data is clearly an industry responsibility. However, as a result of our experience in the development, test and evaluation, and transfer of both sensor technology and data interpretation techniques, the following activities are observed as being important elements of such private sector marketing:

- Understanding of using organizations' information needs and decision-making processes.
- Informational programs to significantly extend user awareness of the technology and its applications.
- Combination of satellite remote sensing data with conventional data in geobased information systems and the interactive analysis of these data.
- Acquainting the user with information products (e.g., fire hazard maps) developed from satellite data, rather than just with the raw satellite data.
- Access to data to make it readily and reliably available.
- Low cost user data processing systems and products (e.g., remote terminals, distributive processing).
- Low cost/low risk technical assistance to new evolving users.
- Technical training to build a cadre of informed and capable personnel.

QUESTION E-2:

One of the major complaints by many users is the timeliness with which they receive the data. How would you see the system operating in a more effective manner?

ANSWER E-2:

Timeliness as a factor of importance to users must be considered in several classes: (a) cases where the data are ephemera', as in agriculture or disaster assessment; (b) cases where the data are not ephemeral, but the need is urgent because the data are in support of other operations, as in planning for mineral explorations;

and (c) cases where delay in filling an order for data appears inexplicable. In all of these uses, management which is devoted full time to operational production can help; but substantial improvements can come only with changes in system equipment. A research and development (R&D) system is not intended to cut delivery time of standard products to the minimum. The period of Landsat R&D operation has seen changes in processing methods as we learned where the critical points were. In the Landsat-D ground system now under development, we are able to design high reliability, high production and quality control features into it for the Multispectral Scanner while maintaining experimental flexibility for the Thematic Mapper. In the event that market response indicates a need for further improvements in reliabiiity and timeliness, the Landsat-D ground system has been designed so that additional equipment could be procured to effect those improvements.

QUESTION E-3:

Our policy in the past has been one of nondiscriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

ANSWER E-3:

Nondiscriminatory distribution of data has been useful in allaying concerns about misuse of the data; and direct reception of data by foreign ground stations has been one method of implementing the practice of nondiscriminatory distribution. Continuing this practice for data distribution could help reassure various interests during a period of growth both in the capability of systems and in the economic value of the information which can be extracted from the data. This does not imply that the method of distribution through direct reception necessarily should be continued unchanged, nor does it imply that any such policy should be applied to derived information which often involved data f om several sources. Disadvantages of continuing the practice in force might include: (a) discouragement of private sector interests that might otherwise invest in systems with certain proprietary features; and (b) inappropriate imposition of government policy on a private sector operation which should be controlled by market forces, rather than government policies.

QUESTION E-4:

What would you consider adequate incentives for private sector investment in a system?

ANSWER E-4:

What incentives private sector interests would find adequate can only emerge during actual negotiations leading to transfer of land remote sensing systems to the private sector. A minimal incentive could merely be that the government would refrain from as much regulation and policy constraint as is legally permissible. Additional incentives could include monopoly status, guaranteed purchases of product by the government to meet valid government needs, transfer of assets at some low price, and/or continuing outright government subsidy to a level that protects against commercial net loss. Somewhere in the scale of increasing incentives the influence of the government would overwhelm the independence and risk taking expected of the private sector and the benefits of moving the operation to the private sector would largely disappear.

QUESTION E-5:

Could you describe the industry/government arrangements you are involved with that may be even somewhat applicable to the overall remote sensing issue?

ANSWER E-5:

The following sorts of industry/government arrangements have been used in NASA remote sensing research and development (R&D) and technology transfer programs and may be applicable to the overall remote sensing issue:

a) R&D tasks are performed through standard contracts with industry, e.g., Thematic Mapper development, application technique development;

b) value-added firms used as technical agents in NASA-sponsored test, evaluation, and technology transfer projects so that at the conclusion of the project there will be a private sector firm capable of continuing the dissemination of the new techniques;

c) joint programs with private industry associations, such as the Electric Power Research Institute, are used to provide a nationwide basis for identifying user needs and requirements;

d) open conferences are held to inform industry of the useful results of NASA-sponsored projects; and

e) joint endeavor agreements are concluded with specific firms, under which there is no exchange of funds, but NASA will provide certain services (including flight opportunities), and the firm will develop a capability in which NASA is interested, obtaining in return for its investment an exclusive opportunity for a fixed period of time to develop, test, and evaluate a new technological capability.

QUESTION E-6:

How might you address the distribution of research and development data to prevent it undercutting the operational data?

ANSWER E-6:

Distribution of research and development (R&D) data acquired by NASA could be restricted solely to use in R&D projects in NASA or in organizations which have a formal arrangement with NASA for the purpose of acquiring R&D data. Reproduction of the data for unauthorized further distribution could be prohibited. The volume of R&D data in circulation could thus be kept below a level that would inhibit sales of operationally acquired data, although some stimulation of the prospective market might occur. This pattern of control would require that such R&D data be excluded from the provisions of the Freedom of Information Act, as are certain other types of data.

QUESTION E-7:

Could the present system including Landsat-D and -D' be converted to an operational system? What would it take?

ANSWER E-7:

The present Landsat-D and -D' system is being developed to serve as an operational system insofar as the Multispectral Scanner (MSS) and its associated ground data processing is concerned. It has redundant processing strings and maximizes the use of off-the-shelf, highly reliable hardware. It is designed for 48-hour response to user requests at a confidence level of 85 percent, average over a ten-day period.

QUESTION E-8:

The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

ANSWER E-8:

Research and development (R&D) space systems are designed to push technology forward and improve basic capabilities, which could also imply lower unit costs. Although private sector R&D would be expected to focus more on improving efficiency and costs, the intent of the Federal R&D is to learn the maximum amount from each flight opportunity. Each of the Landsat flights has embodied new capability, and each has therefore required changes in ground equipment and data systems in order to adjust to the not yet clearly understood needs of new groups of investigators, in addition to the needs of more routine users. A fully operational system permits design and organization against a different system of values, many of which equate to stable requirements, efficient performance of well-understood tasks, and cost reductions. Items could include:

a) tradeoffs among various ways to achieve system reliability, given the interaction of various modes of failure and the market for products;

b) adjustments in the product line to produce the greatest market return for investment in capital equipment and operating expenses; and,

c) control over the rate of introduction of new technical features and operating procedures.

QUESTION E-9:

During the 1982 authorization process, the French space agency testified on the SPOT system. They seem to be developing a simpler, less sophisticated system, but one they feel will meet user requirements on an operational basis. Is the United States too caught up in ensuring that our system must be the most sophisticated and complex and, therefore, costly?

ANSWER E-9:

The United States, to date, has been engaged in an R&D program designed to advance the state-of-the-art. Routine users of the data have been involved in the complexity and difficulty of the development more than they would need to be if they were dealing with a routine operational system. France, on the other hand, has used the experience with Landsat to select a set of services, among all those technically feasible, and has regularly maintained a commercial tone in dealings with potential users. France has not emphasized the cost of the system, or the technical complexities -- which are considerable -- or the possible problems they may have in producing an adequate flow of data products. There is no solid evidence that the SPOT system will be less costly than Landsat-D, although the price of data to users could be lower if the French Government chooses to subsidize early users.

QUESTION E-10:

Have you considered different types of systems to meet different user needs?

ANSWER E-10:

Using different types of systems to meet different user needs is currently being studied by NASA, and has been the subject of past studies.

QUESTION E-11:

Is it your experience that foreign nations are using our Landsat data at a much greater rate of growth than domestic users? Why does this appear to be the case?

ANSWER E-11:

There has been a more rapid rate of growth in using Landsat data among the lesser developed countries (LDC) than among domestic users. This rapid rate of growth is probably due to the fact that many of these countries lack information concerning their natural resources. Unlike the United States and other developed nations, the LDC's do not have adequate conventional data bases, or means to develop them particularly in remote areas. Landsat data offers an effective and economical means to obtain the required data.

Another reason for the rapid growth of satellite remote sensing use among LDC's has been the availability of U.S. and other international financial support for the application of new science and technology in these nations. Through AID and the United Nations, U.S. universities have participated in demonstration projects and training of foreign nationals from a number of countries, (e.g., Senegal, Syria, Mauritania, Nepal, Egypt, Sudan, India, Spain, Mexico, Chile, Argentina).

QUESTION E-12:

Are you aware of aggressive marketing by the French for SPOT data?

ANSWER E-12:

The French have reportedly contacted several commercial entities in the United States and other countries in an effort to create and expand a market for SPOT data.

Responses to Written Questions from Congressman Flippo Resulting from the July 22, 1981, Joint Hearing before the Senate Subcommittee on Science, Technology and Space before the Senate Subcommittee on Space Science and Applications at which Mr. Beggs testified.

QUESTION E-1:

The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.

a. What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be serviced by a single satellite or system of satellites?

b. Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

ANSWER E-1:

a. Many types of resource observations can be and are combined on single satellites or systems of satellites. Factors dictating independent or dedicated systems include requirements for day versus night observing times, such as (a) thermal infrared observations required for geological classification; (b) particular orbital inclinations, such as polar versus sun synchronous; or (c) particular sun angles, which are determined by the time of nodal passage, that are important for crop classification. NASA is currently studying the various system requirements necessary to meet these diverse requirements. Where conflicting requirements of the type mentioned above do not exist, multiple sensors can be combined on single satellites to reduce costs.

b. Data from weather satellites would be useful in programming sensors which require data in the visible and infrared regions of the spectrum to avoid acquiring useless data in cloud covered areas. The combination of these sensors on a single satellite in low Earth orbit may prove difficult because of the different sun angle requirements for accomplishing the necessary measurements. It would be possible to combine geosynchronous orbit weather satellite instruments on the same bus with communications transponders. However, the required location of these satellites in the geosynchronous arc, east and west of the United States would be nonoptimal for communications purposes.

QUESTION E-2:

Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of Landsat system and whether the system should be operational now.

a. What is your opinion of the present status of Landsat? Is it ready for operational use?

b. What is the applicability of Landsat-D to an operational system?

c. Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 1980's with the present approved program?

ANSWER E-2:

a. and b. The Landsat system presently in service (Landsat-2 and -3) was implemented for research and development (R&D), not operational service, but the Landsat-D and -D' system is being developed as an operational system insofar as the Multispectral Scanner (MSS) and its associated ground data processing is concerned. It has redundant processing lines and maximizes the use of off-the-shelf, highly reliable hardware. The ground system has been designed for 48-hour response to user requests at a confidence level of 85 percent, averaged over a ten-day period. The primary operational sensor on board the Landsat-D and -D' spacecraft is the MSS, an instrument type which has a ten-year operating history in which it has always greatly exceeded design life. There is every reason to expect that the system will perform as a satisfactory operational system well into the late 1980's.

c. To maximize timeliness of data delivery, ideally, the system should be designed and developed from the start as a high-realiability, high-volume production system with quality checks on 100 percent of the data products. The Landsat-D system will approximate that kind of performance. In order to insure the effectiveness and efficiency necessary to respond to user demand in a timely manner, highly reliable, state-of-the-art components should be utilized, and redundant data processing lines are necessary. An adequate number of trouble-shooting and data quality check subsystems is also essential. Again, the Landsat-D ground system will meet those requirements. Although our confidence in the space segment is high, there would be delays in reestablishing service in the event of premature spacecraft failure.

QUESTION E-3:

Policy issues relating to the proper government/private sector relationships and the scope of the involvement of the commercial sector are in need of further clarification.

a. By what process should responsibility for remote sensing move to the private sector?

b. Do you believe that the private sector could successfully operate both the space and ground segments on an operational system (leaving aside the question of finances)?

c. Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

d. How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and, thus, inhibiting innovation?

e. Is a copyright provision necessary for private sector operations?

f. Is the concept of nondiscriminatory data access compatible with the private sector involvement? How important is this concept?

g. Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

h. How should a private sector operator be regulated, if at all?

i. Who should do research and development? Should industry help pay for government R&D if the system is transferred to the private sector. By what mechanism?

j. How should the sale price for government equipment be determined for a transfer to the private sector?

k. If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

- With respect to continuity?
- With respect to technical development?
- With respect to market preparation?

l. What would joint ventures between government and businesses contribute to the present system? Is legislation necessary to permit joint ventures?

ANSWER E-3:

a. The Cabinet Council on Commerce and Trade is now reviewing this question to determine the best mechanism for implementing private sector transfer as soon as possible.

b. Undoubtedly, the private sector could successfully operate both segments of an operational system, since the operation of the current system is carried out by private companies under government contract.

c. Some potential owner operators have argued that a monopoly, at least as to raw data products, is necessary in order to induce any commercial organization to make the necessary investment for system operation. Others have indicated a willingness to invest in remote sensing systems even if there is significant domestic and foreign competition. Multiple industries are expected to participate in the value added segment of the market. Disadvantages of a monopoly operation include possible business failure by the operator which could provide a major break in data continuity, increased likelihood of higher prices, less market responsiveness, and curbs on future industry growth.

d. It is difficult to estimate the requirement (if any) for "guaranteed government business" since this would be a function of the type of operation proposed and the amount of risk capital involved. A major factor would be whether the commercial operator runs only the existing system or whether the operator is encouraged to set funds aside to develop next-generation systems. To the extent that government studies effectively guarantee the profitability of the commercial operation, it would vary little from the present system which is operated by contractors for the government, and there would be little incentive for innovative management.

e. Copyright provisions or equivalent protection for data are almost surely necessary to successful operation by the private sector.

f. We believe the concept of nondiscriminatory data access is compatible with the private sector involvement. This assumes that "nondiscriminatory data access" means that the raw or preprocessed data products will be available to all who wish to purchase at the same price. Of course, market prices would reflect any value added in collection processing or distribution. If one assumes the term "nondiscriminatory data access" means that all who wish to purchase data can purchase it at a price low enough to make its use for any desired purpose economically viable, then sales at a price low enough to support projects of marginal value would be too low to support the costs of the commercial operator.

g. If a private organization created its own satellite system for resource observations, not to be in the business of marketing the acquired data but rather to use the information it could derive from the data, then it would certainly have proprietary rights to the derived information. Such an organization might wish to recover some of its costs by marketing the raw or preprocessed data acquired from the system. We know of no reason why proprietary rights in this data would not exist through normal copyright procedures. It would, of course, be necessary that the operation be conducted consistent with the international obligations of the U.S. Government.

h. Necessary constraints on operation of the system, such as protecting national security, could be written into any resulting agreements. Existing laws are sufficient to cover other restrictions or policy provisions.

i. The level of continuing government support for long term fundamental research in land remote sensing systems and technology would depend on the priority established in future budget years. However, industry should assume responsibility for conducting research and development (R&D) to improve system operation and profitability and should be able to cooperate with and contribute resources to the government R&D program if operational improvements will result. Several mechanisms already exist for NASA to cooperate with industry, such as: (1) engaging in joint arrangements with U.S. domestic concerns in research programs directed to the development or enhancement of U.S. commercial leadership in processes which utilize the space environment; (2) conducting research programs having a final objective of enhancing U.S.

capability by developing space-related, high risk, or long-lead-time technology; and (3) entering into transactions with U.S. concerns designed to encourage the commercial availability of NASA space flight system products.

j. The Administration is examining this issue.

k. The question of initial government operation of a remote sensing system is answered in the context of Landsat-D. Since that launch is about one year away, a major factor in considering interim operations is the length of time required for the selection and make-ready time of a commercial operator. If that operator is not in a position to take over immediately after launch, there is an obvious requirement for government operation. Assuming that this requirement does not exist, the following response is provided:

- Continuity should not be affected if a commercial operator proceeded immediately to take responsibility for the system. Arrangements might well be required for technical consultation with NASA in the event of spacecraft problems; however, this would not be a major deterrent to proceeding immediately with the commercial operator.

- Technical development is an area in which continuing government participation would be most appropriate. However, in a commercial operation, the government's efforts would not involve nearer-term or product improvement changes particularly in the ground system, which would be the responsibility of the commercial operator. No particular advantage or disadvantage is perceived from interim government operation, so long as such operation is appropriate to the transfer process.

- Market preparation will result only after an operator is selected (excluding those activities necessary for proposal preparation) and should be unaffected by the identity of the operator during the initial period.

l. Joint ventures succeed when both parties have a valid interest in achieving the end result, when a rational allocation of expenses results in affordable costs for each party, and when the allocation of tasks builds on the particular strengths of each party. The Administration has stated an intent to move operational land remote sensing into the private sector, and there are a number of possible areas of activity that will support that goal. The strengths of the private sector are surely in efficient operation and the development of new markets; those of the government are in space technology and major system design. Decisions on whether joint activities should be started will rest on whether or not the private sector will be able to afford the necessary steps without a government contribution through joint ventures, and the value of the government of having the various remote sensing capabilities continued in a timely manner.

A requirement for authorizing legislation will depend on which agency is involved and what the function of the venture is. In many areas, NASA is already authorized to engage in joint ventures.

QUESTION E-4:

Universities are currently involved in research and training in the area of remote sensing.

a. How is the contribution of universities important?

b. What should be the role of universities in the future, i.e., if we have an operational system? What should be the role of the Federal government vis-a-vis universities?

c. How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

ANSWER E-4:

a. Through the public service charter of the universities, state, local and Federal agencies have been exposed to the potential of remote sensing to local problems through demonstrations, workshops, conferences, talks at civic organization meetings, and continuing education programs.

Through their research and education charter, the universities have conducted joint demonstration projects with user organizations and have provided training to the resource managers of the future. As a result, remote sensing has become another resource management tool that resource managers have learned to use and can call on as appropriate. In addition, universities have conducted basic and applied research in the application of remote sensing to various public and private resource problems.

b. It is important that the universities continue to be involved in research, education and public service during the evolution of an operational system. The universities should continue to provide a source of expertise for research on new remote sensing systems, information extraction techniques, as well as applications. They should also continue to be an important source for public and private user organizations for training and value-added data analysis services. The Federal government, on the other hand, is in a better position to assess its own information needs which could be satisfied by remote sensing technology and carry out the high risk research and development, and test and evaluation of new technology.

c. Overall, commercialization is likely to have a number of key benefits for universities. It will increase the demand for trained personnel in user organizations and value-added firms and will greatly increase the use of remote sensing data on a routine basis. The universities will receive the benefits of this routine use through increased need for research as well as routine data analysis service for users. The danger for university programs is that without guaranteed support they will be subject to the uncertainties of the competitive selection process. The competitive selection process could result in reductions of Federal funding support for some university centers, but the best centers are expected to continue.

QUESTION E-5:

Satellite data is being utilized to provide data for public services.

a. How is the utilization of remote sensing data important to the public welfare and health?

b. To what extent are state and local governments utilizing this data for public services?

c. What are the primary concerns of the state governments (1) with the system as it would be if Landsat-D (and then D') were run by NOAA as they are now running Landsat-2 and -3? (2) with the future commercialization of land remote sensing?

ANSWER E-5:

a. A number of Federal agencies, such as Corps of Engineers and the Bureau of Land Management, make extensive use of Landsat data for public service functions. The states have been especially articulate in stating their views, often in direct testimony. Our understanding is that remotely sensed data is viewed by the states as important to the public welfare and health because it yields information needed to improve management decisions in economic development and planning, environmental management, and maintaining the quality of life.

Resource inventories (e.g., forests, minerals, surface water, prime agricultural land) provide a sound, objective basis for economic development and planning by delineating what is available for use, how resources are being maintained, and how renewable resources (such as forests) are being managed. The data are used not only in finding resources but in making tradeoffs between alternative uses of resources to guide development such as urban expansion.

To successfully execute these responsibilities at the lowest cost, state and local governments may want increasingly large and diversified quantities of data on a recurring basis. In all of those areas related to the public welfare and health, satellite data hold the promise of helping the states make more informed decisions and regularly monitoring the impact of those decisions. The unanswered question is whether the benefits returned to state and local governments will justify expenditures sufficient to cover the market costs of satellite remote sensing data.

b. Current state government uses of satellite data for public services were summarized in a May 1981 report by the staffs of the National Conference of State Legislatures and the National Governors Association. Based on a survey of lead resource agencies in each state, the report lists 594 applications of Landsat data; a growth of 61 percent from the 371 applications surveyed 3 years earlier in 1978. In addition, 15 states are identified as having routine operational capabilities to use Landsat data.

The largest number of applications was in the area of environmental management (water quality planning/assessment, coastal zone management, environmental impact) followed by forest/rangeland management and water resource management (surface water inventory, water resources planning/management (surface water inventory, water resources planning/management, etc.). Direct local government use of satellite data has been substantially less than state use. Interest has been growing and could increase markedly with the availability of higher resolution data from Landsat-D.

c. The concerns of state and local government regarding operation of the Landsat system were most explicitly stated a year ago in recommendations by the National Conference of State Legislatures and the National Governors Association. These concerns were:

- data continuity
- frequency of observation
- availability of technology transfer
- participation in decision-making regarding the system
- capabilities of the operational system
- improvements to the data processing systems
- drastic increases in data prices
- copyright restrictions
- maintenance of archiving

Summarized more generally, state concerns involve dependability of the system, responsiveness to state data needs, and sensitivity to the needs of a not yet fully matured user community.

(1) Landsats-2 and -3 are, of course, still operated by NASA. It is our understanding that with the exception of a desire for more dependability and responsiveness in the data system, there is no major concern with current satellite operations as conducted by NASA - or as proposed by NOAA when the transfer is made.

(2) It is our understanding that the main concern of the states regarding future commercialization of the Landsat system is that the system may be structured for a full cost-sharing approach in spite of its public and socio-economic benefits.

QUESTION E-6:

There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop.

a. Is present data receipt and handling centralized? What are the advantages and disadvantages?

b. Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

ANSWER E-6:

a. In consideration of centralized versus distributed data receipt and handling, the most important factors to the user community are reliable and timely receipt of the data, consistent quality, and low-cost data products. With the exception of the Landsat foreign receiving stations, the present data receipt and data handling system is centralized. The advantage of a centralized system is that it produced products of similar quality in a standardized format and assures compatibility of data on a nationwide basis. The predominant disadvantages are: (1) possibility of system backlog of data due to the large volumes and single throughput points; (2) vulnerability to single point failures due to hardware or software failures, or even labor problems; (3) a single geographical location which hinders user access for data searches and communication.

b. Taken in the large, the present system is already one designed to take data from a single satellite, pass it through several transformations of data analysis and interpretation, and ultimately deliver it to literally thousands of users who usually combine the Landsat data with the data from other sources in the final step of generating information. The system design question is then one of deciding at what point in the cascade one changes from centralized to distributed. Obviously having multiple channels of distribution adds redundancy to the total system, but at some additional cost and some problem with how much additional traffic the remaining channels can handle should one of the regular channels fail. The channels can develop specialty characteristics ranging from particular geographic coverage to a concentration on special data products tailored to particular groups of users. Generally, a more fully distributed system will be able to cater to user interests more easily, but cost, management complexity, and ability to query the entire data base will be increasingly difficult.

QUESTION E-7:

There is a need to clarify how remote sensing data could or should be priced.

a. For a government-operated system, should there be a pricing structure. For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

b. If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?

c. For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

ANSWER E-7:

a. For a government operated system, there should be a pricing structure other than the marginal cost of reproducing the data products. Prices for various types of products can depend on quality, amount of information, timeliness, required special processing, and so forth, with the goal of total revenue being recovery of system operating costs. The price for each class of product should be the same for all users, although quantity discounts for large orders of a particular product could be considered.

b. Any consideration of recovery of sunk costs needs to take into account the fact that prior expenditures were not justified for the creation of an operational system, but primarily for research and development purposes.

c. For a private system, data product prices should be determined in the open market, and not be government prescribed.

QUESTION E-8:

The following questions do not have to be considered Landsat specific, but can be reviewed as pertaining to remote sensing from space in general.

a. Do you feel the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

b. How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

ANSWER E-8:

a. Recognition of the importance of remote sensing from space has been clearly demonstrated by this Administration and several past Administrations by the substantial investment to date in the Landsat program. Articulation of its importance was clearly provided in commitment to establishment of an operational system; again, this was initiated by the past Administration and confirmed by the current Administration. Reinforcement of this commitment at a more detailed level is being made by the constituent agencies of the Federal government in terms of their individual interests and progress toward increased use and acceptance of remote sensing. Significant civil uses of satellite remote sensing are either in place or under development in a number of Federal agencies including the Department of Interior, Department of Agriculture, and the Corps of Engineers.

b. Government policy can deal with the creation of operational systems to carry out existing functons, but it is more difficult to deal with creating systems to carry out functions that have hitherto been unknown, and are thus in some sense unproved until a system has been in operation. Even so, the government policies have included a number of very positive features: support for a series of research and development satellites, the output of which could be used to support preliminary operational tests; supporting worldwide availability and use of the data, thus creating the awareness that the new capability was valuable; the allocation of Federal funds to work with various user communities to develop new applications; provision for satisfying present users of MSS data by adding a MSS sensor to the Landsat-D design.

Senator SCHMITT. Our next panel is Mr. Thomas J. Anderson, National Conference of State Legislature and Mr. Bruce Rado, program coordinator, Georgia Department of Natural Resources, and representing the National Governors Association.

Is it R-h-a-d-o or R-a-d-o?

Mr. RADO. R-a-d-o.

Senator SCHMITT. Gentlemen, the Congressmen should return shortly. If you wish, you may go ahead with your statements. If you wish to summarize, please do and we'll make your full statements available in our record.

STATEMENT OF THOMAS J. ANDERSON, NATIONAL CONFERENCE OF STATE LEGISLATURES, ACCOMPANIED BY PAUL A. TESSAR, PROJECT DIRECTOR, NATURAL RESOURCE INFORMATION SYSTEMS, NCSL; BRUCE RADO, NATIONAL GOVERNORS ASSOCIATION PROGRAM COORDINATOR, GEORGIA DEPARTMENT OF NATURAL RESOURCES, ACCOMPANIED BY BARBARA DYER, ASSOCIATE DIRECTOR OF NATURAL RESOURCES

Mr. ANDERSON. Thank you. Mr. Chairman. My name is Tom Anderson. I'm a member of the Michigan House of Representatives and serve as chairman of the National Conference of State Legislatures' Natural Resource Information Systems Task Force.

With me on my left is Mr. Paul Tessar, who is staff director of the task force for NCSL.

NCSL is an organization which serves all of the Nation's State legislatures, all 50, and the task force which I chair represents the interests of those States regarding satellite remote sensing and information systems of satellite data for use in natural resource policymaking.

The States have found the Landsat system to be a most useful tool in our State natural resources program.

One year ago I testified before the Subcommittee on Science, Technology and Space of the Commerce, Science, and Transportation Committee. At that time, I detailed our concerns about the transition plan for a civil operational land remote sensing system, especially those relating to technology transfer and data continuity.

The complexion of the land satellite system has changed some sine then, as you've indicated in your opening remarks, Mr. Chairman. The current administration has opted to investigate alternative mechanisms for institutionalizing the Landsat system, one which will quickly eliminate Federal ownership, operation, and maintenance of the system. Instead, the private sector is being looked to for assuming ownership and operation of the system. We in the States, Mr. Chairman, are alarmed that such a major change in Federal policy and direction might not be examined closely enough.

The invitation to testify indicated that the purpose of this hearing today was to give the views of witnesses regarding the interim operational status of the system, the scope of the system required to meet various objectives, the role of the Government, and legislation or institutional arrangements that would facilitate private sector involvement.

The States, of course, have a vested interest in all of these areas. However, I will limit my statement to those issues that most directly affect State applications of the technology: Government/private sector roles and relationships; technology transfer needs; data continuity concerns; and user input.

We understand the emphasis on turning the land satellite system over to the private sector for ownership and operation. The framework under which the system operates must, however, take into account that the three segments of the Landsat system may need to be handled differently. Our experience has caused us to develop State perspectives on what roles the Federal Government and private industry should play in each of these areas.

The space segment of the system, Mr. Chairman, has been developed at vast cost, completely from tax dollars paid by the citizens of this Nation. If the Federal Government chooses not to maintain this segment, but rather, turns it over to the private sector, the outcome is obvious: State and local governments would be hard pressed to afford to purchase data products that are priced to recover portions of this capital investment. And the development of a broad-based market would certainly be stunted, perhaps set back several years, or permanently.

Furthermore, we raise the question of whether the Nation could justify making a gift of the land satellites to the private sector. I agree completely with the observations of Congressman McGrath earlier this morning in that regard. America's citizens have paid for these satellites, Mr. Chairman. They were, admittedly, developmental, but it's only reasonable that the American public receive the benefits of them without having to pay out even more dollars to the private sector for the privilege of having access to the data collected by them with these tax dollars.

On the other hand, ground data reproduction and distribution segment of the land satellite system appears to have developed a fairly solid foundation. The Department of Interior's EROS Data Center in Sioux Falls, S. Dak., already serves a vast number of users, a worldwide system of users. Only small increases in costs of data products and/or the user community would make this area a profitable venture for private sector firms. It may well be that the time is right to transfer this segment into private hands, although the States certainly have no objection to it remaining under the control of the Federal Government, if that should be the policy decision.

Although we have some concerns that the private sector, motivated by profit, may not always have long-term State needs in mind, we're willing to work with whatever companies are involved to develop approaches for meeting both their needs and ours.

With respect to transferring the technology for applications use, we believe that it would be appropriate for the private sector to provide this service to other private industries. We don't think, however, that it would be appropriate for them to undertake this activity for State and local governments. Landsat technology has been developed by the Federal Government with public funding, as we've said before. For State and local governments to have to pay private sector firms to transfer this publicly developed technology is not appropriate.

Using a philosohpy that the rightful role of government is to provide services which the people cannot provide as efficiently for themselves, we believe the Federal Government has an obligation to all public sector users. The NASA regional applications program has made a strong start in this direction.

In previous testimony before these committees, I've indicated our concern in the States for a strong technology transfer operation. Technology transfer remains the No. 1 issue of concern to us. Given the $1 billion investment—$1 billion—in the Landsat program, we believe it would be shortsighted not to spend the relatively little extra required to assure that the technology is readily available to the States, to the people who can benefit from its being there.

Since the launch of the first land satellite in 1972, 25 States have developed or are in the process of developing Landsat capabilities to meet many natural resource data requirements in areas such as agricultural assessment, wildlife management, water resources planning, and so forth. The success of Landsat implementation in many of these States can be largely attributed to the technology transfer programs undertaken by NASA in the early years of Landsat and continuing to this date. Programs that have been especially helpful to the States include NASA's regional applications program and the user requirements and awareness program.

I believe it important to say that given an assurance of data availability and technology transfer assistance, additional States would be quickly added to the ranks of those already utilizing the system. We could easily have almost every State in the Nation making valuable and substantial use of space data in their daily operations given this fact.

We understand that technology transfer activities may eventually fall within the realm of the private sector. However, we must recognize that the private sector is not always ready or always willing to take up this role immediately. As Deputy Secretary Wright has said earlier, in the short- to mid-term, the Federal Government will need to continue providing some level of services to State and local governments and to plan for an orderly phaseout of technology transfer programs, while at the same time facilitating a phasing in of private sector services.

I want to emphasize that. It has already been brought out in this hearing this morning. Continuity is most important to users of the program. Continuity must be maintained.

A drastic reduction or outright elimination of NASA Landsat technology transfer activities would have a severe impact on the States' use of the system. We hope, therefore, that the Congress will take appropriate actions to see that such activities will be supported through at least the next 2 fiscal years. This would entail only a modest investment, according to the original budget figures that we've looked at, of $9 million annually in the NASA technology transfer budget, half of which could be specifically earmarked to support the regional applications program and the user requirements and awareness program which have proved so valuable to us.

The issue of data continuity, which I mentioned earlier, concerns us deeply, as it has in the past. Plans for Landsat D″ and D″′ have been scrapped, as you've already indicated. We're now faced with a real prospect of two data gaps during this decade, given our total reliance on Landsats 2 and 3, which have had a shaky history, and Landsats D and D', which are unknown quantities at this moment.

We urge these committees to reconsider the impact that such data gaps could have on the States and other users, especially in monitoring applications. As I indicated earlier, Landsat is relied on to provide timely data for flood damage assessments, monitoring of snow packs for predictions of water availability, monitoring timber clear-cuts for tax assessment purposes, wildlife purposes, and so on.

All of these applications rely on the routine coverage provided by Landsat. I hope, therefore, that you will reevaluate the long-term effects of eliminating Landsat's D" and D"'. This issue needs immediate attention because of the long lead times required to construct and get a satellite into viable operative status.

The National Conference of State Legislatures and the National Governors Association/Council of State Planning Agencies, from whom you'll hear in a moment, have for many years served as forums to provide State input to the Landsat program and to related technologies. Representation of the States has been accomplished through the Natural Resource Information Systems Task Force, which, as I said earlier, I chair, and the CSPA's Earth Resources Data Council, which Mr. Rado chairs.

As indicated earlier this morning by Deputy Secretary Wright, a user advisory committee has been established by the National Oceanographic and Atmospheric Administration, which would provide the formal framework for State and other participation in management decisions related to the civil operational land remote sensing program. We believe strongly that members of both the task force of NCSL and the ERDC should be appointed to the User Advisory Committee we've heard about in order to assure adequate representation of the States and their viewpoints as users of the system.

Other concerns involve the need for a guaranteed data market, and the focus and scope of an operational system.

The private sector would, naturally, be unable and unwilling to provide Landsat products and services unless there was some assurance that a sizable market existed to use those products and services. An incentive that private companies would likely require is a guaranteed market from the Federal Government. Further, a private operator would also prefer a prohibition of reproduction of data as a means to protect their market. An additional tactic might be the elimination or reduction of research and development data that may find its way into the market.

We find the potential tactic of a prohibition of data reproduction to be particularly unpalatable. The States operate on "bare bones" budgets, and frequently rely on the exchange of information among and between agencies to fulfill their data needs. Often, a single computer tape can be used by several agencies to provide information needed for a variety of resource problems.

Thus, if the States cannot reproduce such products, a significant portion of the benefits that may have been realized through their use are lost to the States, and indeed to the Nation as a whole.

The needs of the States for Landsat data have been adequately met by the existing multispectral scanner and two-satellite configuration. The thematic mapper designed for the Landsat D series should provide even greater potential for other applications requiring better spatial and spectral resolutions.

The two-satellite configuration of past years has provided tremendous flexibility for many natural resource applications. We would like to see this continued, but recognize that fiscal constraints may make it unlikely during this decade. However, as the user segment expands and the demand for products increases enough to support the construction and launch of additional satellites, the two-satellite approach should be reinstated.

Regarding other satellite features that would be desirable, the proposed User Advisory Committee discussed previously would be the appropriate forum to express such needs. Members of the committee would be able to provide continuing feedback on the sufficiency of current systems features, and the need to enhance various technical features.

The issues I have addressed today—the roles of the Federal Government and the private sector, technology transfer, data continuity, user input, and others—are those that we believe are critical to the continued use of land satellite data by the States. As Congress and the administration outline the framework of the land satellite system, and prepare strategies for insuring that the information provided through this system gets to the users, I urge you to keep these concerns in mind. Our foremost interest is, indeed, to work with you to insure that this tool does not fall to the wayside simply because the data products are made unaffordable for the States, or because the system does not provide the timely data that I believe has been one of the main advantages of this system in the past.

On behalf of the National Conference of State Legislatures and the Natural Resource Information Systems Task Force, thank you for allowing me to present our perspectives on certain aspects of the land satellite system. If we can be of further help, please call on us.

[The prepared statement of Mr. Anderson and an executive summary of State applications of, and investments in, Landsat technology, plus answers to questions asked by Mr. Anderson follow:]

Statement of

The Honorable Thomas J. Anderson
Michigan House of Representatives
The National Conference of State Legislatures
Natural Resource Information Systems Task Force
before the
Senate Subcommittee on Science, Technology and Space
and the
House Subcommittee on Space Science and Applications

July 22, 1981

Mr. Chairmen and members of the committees:

My name is Tom Anderson. I am a member of the Michigan House of Representatives, and serve as Chairman of the National Conference of State Legislatures' (NCSL) Natural Resource Information Systems Task Force. NCSL is an organization which serves all of our nation's State Legislatures, and the NCSL Task Force which I chair represents the interests of the states regarding satellite remote sensing and information system technology for use in natural resource policymaking. The states have found the Landsat system to be a most useful tool in our state natural resources programs.

RESPONSE TO PURPOSE OF HEARING

A year ago, I testified before the Subcommittee on Science, Technology and Space of the Commerce, Science and Transportation Committee. At that time, I detailed our concerns about the Transition Plan for a civil operational land remote sensing system, especially those relating to technology transfer and data continuity.

The complexion of the land satellite system has changed some since then. The current Administration has opted to investigate alternative mechanisms for institutionalizing the Landsat system -- one which will quickly eliminate federal ownership, operation, and maintenance of the system. Instead, the private sector is being looked to for assuming ownership and operation of the system. We are alarmed that such a major change in federal policy and direction might not be examined closely enough.

I understand that the purpose of this hearing today is to hear the views of witnesses regarding the interim-operational status of the system; the scope of the system required to meet various objectives; role of the government; and legislation or institutional arrangements that would facilitate private sector involvement in the land satellite system. The states, of course, have a vested interest in all of these areas. However, I will limit my statement to those issues that most directly affect state applications of the technology, namely: (1) Government/private sector roles and relationships; (2) Technology transfer needs; (3) Data continuity concerns; and (4) User input.

Governmental/Private Sector Roles and Relationships. We understand the emphasis on turning the land satellite system over to the private sector for ownership and operation. The framework under which the system operates must, however, take into account that the three segments of the Landsat system may need to be handled differently. These segments are the space, ground, and applications segments. I will describe state perspectives on what roles the federal government and private industry should play in each of these areas.

The space segment of the system has been developed at very high costs, completely from tax dollars paid by the citizens of this nation. If the federal government chooses not to maintain this segment, but rather, turns it over to the private sector, the outcome is obvious: State and local governments would be hard pressed to afford to purchase data products that are priced to recover such capital investments, and the development of a broad-based market would certainly be stunted.

Furthermore, I raise the question of whether we could justify making a "gift" of the land satellites to the private sector. America's citizens have paid for these satellites. They were admittedly developmental, but it is only reasonable that the American public receive the benefits of them without having to pay out even more dollars to the private sector for the privilege of having access to the data collected by them.

On the other hand, the ground data reproduction and distribution segment of the land satellite appears to have developed a fairly solid foundation. The Department of the Interior's EROS Data Center already serves a vast number of users. Only small increases in costs of data products and/or the user community would make this area a profitable venture for private sector firms. It may well be that the time is right to transfer this segment into private hands, although the states certainly have no objection to it remaining under the control of the federal government. Although we have some concerns that the private sector, motivated by profit, may not always have longterm state needs in mind, we are willing to work with these companies to develop approaches for meeting both their needs and ours.

With respect to transferring the technology for applications use, we believe that it would be appropriate for the private sector to provide this service to other private industries. It would not, however, be appropriate for them to undertake this activity for state and local governments. Landsat technology has been developed by the federal government with public funding. For state and local governments to have to pay private sector firms to transfer this publicly-developed technology is not appropriate. Using the philosophy that the rightful role of government is to provide services which the people cannot provide as efficiently for themselves, we believe the federal government has an obligation to see that this technology is broadly disseminated to all public sector users. The NASA Regional Applications Program has made a strong start in this direction.

Technology Transfer. Technology transfer remains the number one issue of concern to the states. Given the $1 billion investment in the Landsat program, we believe it would be short-sighted not to spend the relatively little extra required to assure that the technology is readily available to the states.

Since the launch of the first land satellite in 1972, 25 states have developed, or are in the process of developing, Landsat capabilities to meet many natural resource data requirements in areas such as agricultural assessment, wildlife management, and water resources planning. Fifteen of these states are operational; the remaining 10 are under development. The success of Landsat implementation in many of these states can be largely attributed to the technology transfer programs undertaken by NASA. Programs that have been especially helpful to the states include the Regional Applications Centers and the User Requirements and Awareness Program. Given an assurance of data availability and technology transfer assistance, additional states would quickly be added to the ranks of those already utilizing the system.

We understand that technology transfer activities may eventually fall within the realm of the private sector. However, we must recognize that the private sector is not ready or willing to take up this role immediately. In the short- to mid-term, the federal government will need to continue providing some level of services to state and local governments, and to plan for an orderly phasing out of technology transfer programs while at the same time facilitating a phasing in of private sector services. Continuity is very important to users of the program.

A drastic reduction or outright elimination of NASA Landsat Technology Transfer activities would have a severe impact on the states. Therefore, I hope that you will take appropriate actions to see that such activities will be supported through at least the next two fiscal years. This would entail only a modest investment of $9 million annually in the NASA Technology Transfer budget, half of which should be specifically earmarked to support the Regional Applications Program and the User Requirements and Awareness Program.

Data Continuity. The issue of data continuity concerns us deeply, as it has in the past. Plans for Landsats-D3 and -D4 have been scrapped. We are now faced with the real prospect of two data gaps during this decade, given our total reliance on Landsats-2 and -3, which have had a shaky history, and Landsats-D1 and -D2, which are "unknown quantities".

I urge these committees to reconsider the impact that such data gaps could have on the states, especially in monitoring applications. As I indicated earlier, Landsat is relied on to provide timely data for flood damage assessments, monitoring of snow packs for predictions of water availability, monitoring timber clear cuts for tax assessment purposes, and so on. All of these applications rely on the routine coverage provided by Landsat. Therefore, I hope that you will reevaluate the longterm effects of eliminating Landsats-D3 and -D4. This issue needs immediate attention, given the long lead times required to construct a satellite.

User Input. The National Conference of State Legislatures and the National Governors' Association/Council of State Planning Agencies have for many years served as forums to provide state input to the Landsat Program and related technologies. Representation of the states has been accomplished through the NCSL Natural Resource Information Systems Task Force, and CSPA's Earth Resources Data Council.

A User Advisory Committee has been proposed by the National Oceanic and Atmospheric Administration which would provide the formal framework for state and other participation in management decisions related to the civil operational land remote sensing program. We believe strongly that members of both the NRIS Task Force and the ERDC should be appointed to the proposed User Advisory Committee in order to assure adequate representation of the states.

Other Issues. Other concerns involve the need for a guaranteed data market, and the focus and scope of an operational system.

Guaranteed Data Market. The private sector would, naturally, be unable and unwilling to provide Landsat products and services unless there was some assurance that a sizable market existed to use those products and services. An incentive that private companies would likely require is a guaranteed market from the federal government. Further, a private operator would also prefer a prohibition of reproduction of data as a means to protect their market. An additional tactic might be the elimination or reduction of research and development data that may find its way into the market.

We find the potential tactic of a prohibition of data reproduction to be particularly unpalatable. The states operate on "bare bones" budgets, and frequently rely on the exchange of information among and between agencies to fulfill their data needs. Often, a single computer tape can be used by several agencies to provide information needed for a variety of resource problems.

Thus, if the states cannot reproduce such products, a significant portion of the benefits that may have been realized through their use are lost to the states, and indeed to the nation as a whole.

Focus and Scope of an Operational System. The needs of the states for Landsat data have been adequately met by the existing multi-spectral scanner and two-satellite configuration. The thematic mapper designed for the Landsat-D series should provide even greater potential for other applications requiring better spatial and spectral resolutions.

The two-satellite configuration of past years has provided tremendous flexibility for many natural resource applications. We would like to see this continued, but recognize that fiscal constraints may make it unlikely during this decade. However, as the user segment expands and the demand for products increases enough to support the construction and launch of additional satellites, the two-satellite approach should be reinstated.

Regarding other satellite features that would be desirable, the proposed User Advisory Committee discussed previously would be the appropriate forum to express such needs. Members of the Committee would be able to provide continuing feedback on the sufficiency of current systems features, and the need to enhance various technical features.

Closing Remarks. The issues I have addressed today -- the roles of the federal government and the private sector, technology transfer, data continuity, user input, and others -- are those that we believe are critical to the continued use of land satellite data by the states. As Congress and the Administration outline the framework of the land satellite system, and prepare strategies for ensuring that the information provided through this system gets to the users, I urge you to keep these concerns in mind. Our foremost interest is, indeed, to work with you to ensure that this tool does not fall to the wayside simply because the data products are made unaffordable for the states, or because the system does not provide the timely data that I believe has been one of the main advantages of this system in the past.

On behalf of the National Conference of State Legislatures and the Natural Resource Information Systems Task Force, thank you for allowing me to present our perspectives on certain aspects of the land satellite system. If we can be of further help, please call on us.

From: State Applications of and Investments in Landsat Technology

EXECUTIVE SUMMARY

This report documents state applications of, and investments in, Landsat technology. Information about state uses of Landsat was obtained through a survey conducted by staff of the National Conference of State Legislatures (NCSL), at the request of NCSL's Natural Resource Information Systems Task Force. This effort was supported by the Council of State Planning Agencies' (CSPA) Earth Resources Data Council and staff. This report provides information for evaluating the utility to the states of the Landsat system and the NASA Landsat Technology Transfer Program, for presentation to Congress and the Administration.

The NCSL/CSPA survey and report build upon and update work done in 1978 by the Intergovernmental Science, Engineering and Technology Advisory Panel (ISETAP) regarding the states' needs for an operational Landsat system and for federally provided technology transfer assistance. The ISETAP Landsat study, as well as several federally conducted policy studies, provided the basis for a Presidential Directive in November 1979. This directive called for the development of an operational civil land remote sensing system, and provided a federal commitment to the continuity of Landsat-type data through the 1980's.

The National Earth Satellite Service, charged with implementing the operational program, prepared a plan to upgrade the system from experimental to operational status. The Carter Office of Management and Budget (OMB) supported the plan and recommended adequate funding for its implementation. OMB also recommended sufficient funding for the continuation of the NASA Landsat Technology Transfer Program at that time.

In the twilight of the Carter Administration, over five years of efforts on the part of state and local governments to convince the federal government to build an operational Landsat system were recognized and appeared to be headed toward realization. The philosophy of the Reagan Administration, however, is to accelerate transfer of the Landsat Program to the private sector. Many states believe that an immediate withdrawal of federal dollars from the operational Landsat system and related technology transfer efforts seriously threatens use of the technology by the states. This report is intended to present and document information in support of the need for such activities.

State Applications of Landsat Technology

The states have been in the forefront in developing applications of Landsat data. By July 1978, four states had developed operational capabilities to analyze and apply Landsat data. It was not until the initiation of the NASA Regional Applications Program, however, that most states had the opportunity to evaluate Landsat technology. Following cooperative state/NASA demonstration projects, about 22 additional states developed or are in the process of developing operational Landsat capabilities. To date, 26 states and 135 local or regional entities use, or are developing capabilities to use, Landsat data.

A total of 594 Landsat applications in the states have been documented. Of these, 241 are considered to be operational, and 40 to be routine/continuous. In addition, 131 potential future applications not yet attempted in particular states have been identified.

State Investments in Landsat

The states have made major investments in Landsat since the launch of the first satellite in 1972, including:

- Almost $28 million in total expenditures of state-controlled funds ($10.8 million from state general funds, and $15.6 million in state-controlled federal funds);
- Training for over 3,300 state personnel;
- Over 760 person years of staff time;
- Various institutional arrangements to facilitate the use of Landsat data;
- Over $5 million in expenditures for computer hardware and software; and
- Nearly 20,000 Landsat images ("photos") and 2,700 computer tapes (purchased by states directly, or by others on behalf of the states).

Advantages, Problems and Research Needs

The major advantages of Landsat identified in the survey are:

- Computer compatibility;
- Repetitive coverage;
- Large area coverage; and
- Cost effectiveness.

The major technical problems noted are:

- Data delivery time;
- Knowledge and availability of computers and software; and
- Spatial resolution of the data.

The major institutional problems mentioned are:

- Difficulty of obtaining funding for new programs;
- Lack of state R&D funds; and
- Status of federal commitment to data continuity.

The most pressing research needs appear to be:

- Information systems/modeling;
- Sensor improvement;
- Spatial resolution; and
- Applications.

Conclusions

Many applications and investments have been identified. Landsat has, indeed, proved to be a useful tool for gathering information on natural resources by state and local agencies. The NASA Landsat Technology Transfer Program has materially aided a large number of states in exploring uses of, and in developing capabilities to apply, Landsat data to state resource management problems.

RESPONSE TO QUESTIONS FROM SENATE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE, COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

Hearings on Civil Land Remote Sensing Systems
July 22, 1981

Rep. Thomas J. Anderson, Chairman, NRIS Task Force
National Conference of State Legislatures

1. *You stated that you feel strongly that there should not be a prohibitipn on data reproduction. Wouldn't such a policy severely hamper the expansion of the market and therefore keep prices possibly unrealistically high?*

I do not object to an overall ban on reproduction. I would like to suggest, however, that, within a state, state and local agencies should be allowed to share their databases freely. Public agencies, funded as they are by taxpayer dollars and on running on bare bones budgets should be granted an exemption to the ban. It is clearly in the public interest to promote widespread usage of Landsat data for governmental planning, management and monitoring and public policy formulation.

2. *Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?*

We see continuation of the policy of domesticnon-discriminatory data distribution as crucial. It would be unconscionable for some users to have privileged or limited access to the data for any reason save national security. Foreign policy and domestic "fair play" considerations strongly support the need for such a policy.

3. *The government R&D systems have been fairly expensive as they are experimental systems. In an operational system where do you see cost reductions possible?*

An operational system could eventually reduce overall costs by producing several carbon copy spacecraft at once where only one or two are now produced. An operational system would also encourage accelerated development of user applications, many of which the current experimental system not only discourages but often makes impossible to complete in a relevant time frame. This would result in market expansion, thereby reducing unit product costs to users by broadening the base across which such costs are spread.

I do not, however, see cost savings resulting from combining land and weather sensors on the same platform. The equatorial crossing times required for these applications are not compatible, and any compromise would probably result in substantial lessening of data quality for both applications.

4. *Are you aware of aggressive marketing by the French for SPOT data?*

Yes. This effort, should it bear fruit, could seriously damage our technological leadership position in remote sensing in particular and space applications in general. It would also lessen the value of an important foreign policy tool.

The aggressive French effort, which is heavily subsidized by the French Government, would also pose a serious threat to the profitability of any U.S. private sector operator.

5. *What are your views on single entity operation of the system vs. competition for the various segments of the system?*

Single entity management is extremely desirable from several aspects. It would increase the likelihood of successful coordination between segments of the system and would, hopefully, streamline management. It also would increase the accountability of the system operator.

6. *Have you been participating in the User Workshops that have been conducted by NOAA? What has been your perception of your input into a policy decision*

Many state Landsat users have participated in both series of NOAA workshops. They have provided a useful discussion forum, and have increased user awareness of NOAA plans and proposals. They have not necessarily been useful as a means of influencing NOAA's policymaking process.

The best mechanism for providing user input to this process is through the Program Board and User Advisory Committee. State users could express their needs through the NCSL and NGA representatives, each of which would be members of formally constituted advisory committees of their respective organizations. These committees, in turn, have access to fifty state networks to assure broad representation.

7. *Has your state organization been actively marketing remote sensing information? If so, please explain how you have done this.*

NCSL has not been actively marketing remote sensing technology. We have, however, provided technical assistance and information on Landsat and natural resource information systems technology to interested legislators, staff, and legislative committees.

HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
Questions for Land Remote Sensing Report

1. *The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.*

   (a) *What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?*

   (b) *Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?*

We feel the land and weather systems probably require dedicated platforms due to differing requirements for equatorial crossing times.

The Landsat-D system or NOAA's proposed fully operational system, as outlined in the Transition Plan, represent successful compromises in wavelength coverage and orbit patterns and a realistic tradeoff between spatial resolution and data rates. As such, they satisfy a large majority of user needs at minimal cost given current technological capabilities.

It may be possible to combine geosynchronus communications satellites with geosynchronus weather satellites. I would defer to the experts as to the technical feasibility of such an approach.

A potential area of consolidation which should be explored is the combination of civil and military weather satellites. If national security concerns could be addressed, this could result in significant savings.

2. *Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of LANDSAT system and whether the system should be operational now.*

   (a) *What is your opinion of the present status of LANDSAT? Is it ready for operational use?*

The current Landsat system is definitely ready for operational use. The states, in fact, have been making many, many operational uses of the experimental system for several years. I would refer you to an NCSL report, State Applications of and Investments in Landsat Technology, a copy of which has been provided to the committees' staffs, for an inventory of the near 600 applications projects undertaken by over forty different states. This report also documents nearly $30 million in state Landsat investments, many man-years of effort expended, and a great deal of data purchased. I would like to request that the executive summary of this report be incorporated into the record of these hearings.

(b) What is the applicability of LANDSAT D to an operational system?

Landsat-D, should the TM work as designed and should the data distribution system work as efficiently as promised, could form the core of an interim operational system.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

Additional spacecraft will be required to have adequate assurance of timely and uninterrupted service through the late 80's. The original FY 82 budget contained funding for a third and fourth Landsat-D spacecraft, and their elimination in the revised budget was, I feel, a mistake we may pay for in five years or so.

3. NO RESPONSE/Issues of major concern addressed elsewhere.

4. *Universities are currently involved in research and training in the area of remote sensing.*

   (a) How is the contribution of universities important?

   (b) What should be the role of universities in the future, i.e. if we have an operational system? What should be the role of the Federal Government vis-a-vis universities?

   (c) How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

The universities and NASA both have important roles in relation to R&D. Both have made significant contributions and should be funded by the Federal Government to continue R&D so as to maintain U.S. technological leadership and prevent a reoccurance of the communications satellite R&D lapse.

5. *Satellite data is being utilized to provide data for public services.*

   (a) How is the utilization of remote sensing data important to the public welfare and health?

   (b) To what extent are State and Local Governments utilizing this data for public service?

The states have extensively utilized remote sensing data in a multitude of ways to promote the public welfare. I would refer you to State Applications of and Investments in Landsat Technology for a listing of nearly 600 different projects or programs which were assisted by the use of Landsat data. These projects are listed by state, discipline and category (operational use vs. demonstration projects). The uses completed to date are only the tip of the iceberg. (Executive Summary will follow question #8.)

(c) What are the primary concerns of the state governments (i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3? (ii) with the future commercialization of land remote sensing?

The primary concerns of the states for the system proposed by NOAA in the transition plan have been outlined in detail in previous testimony before the Congress. Briefly stated, our major concerns are for data continuity, the continuation of the NASA Landsat Technology Transfer Program, and for state representation in Federal Landsat decision making.

Our concerns for a commercial system are similar, with one additional major point. Private sector attention could be focused on the requirements of major users only, with state concerns given short shrift. The states are relatively small users when considered in the perspective of the entire potential Landsat market, probably less than 10%. The public policy significance of their usage, however, is much larger than the gross dollar volumes of state purchases. With increasing responsibilities thrust upon the states and increasing demands for their limited resources, the states should be considered important users out of proportion to their "market share" and should have a major voice in Landsat decision-making, whoever runs the system. It would be a terrible waste if our states were not allowed to benefit from the $1 billion investment in Landsat technology to the fullest extent possible.

6. NO RESPONSE.

7. *There is a need to clarify how remote sensing data could or should be priced.*

   (a) *For a government-operated system, should there be a price structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?*

The current uniform pricing structure is satisfactory. Standard products all have standard prices, regardless of when the data were acquired. Users who wish to have priority processing on their orders pay three times the normal price regardless of when the data were acquired. Perhaps consideration should be given to reducing this surcharge when the standard prices are increased, but the principal is still valid.

Different spectral bands should not be priced differently. Uniform prices for all users would appear to be desirable, although the states would certainly not be adverse to any subsidies to reduce the costs of data directly or indirectly for state and local governments.

The overall price structure should be determined by the results of market studies, recognizing the need for the system to recoveron ever increasing portion of costs, and allowing users time to adjust to increases over time. We should, at all costs, avoid what I will term the "mass transit spiral" where increasing fares cause decreasing ridership resulting in a net reduction of revenues. We should not attempt to suddenly get current users to pay the full system costs, but should aggressively attempt to broaden the market so as to increase the size of the base over which costs are spread. Price increases should be small, phased and announced several years in advance so as to promote rather than discourage increased usage.

   (b) *If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?*

If the system is to be government run, operational, maintenance, data processing and data distribution costs should be recovered starting no earlier than January 1, 1985. This will allow states with biennial budgets to adjust to the increases rather than proportionately reducing the amount of data purchased with a fixed budget.

There should be no attempt to amortize hardware costs till at least the end of the decade to avoid the "mass transit spiral". Research and development costs should be supported by the Federal Government through the end of the century.

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

A private system should be required to be sensitive to the several concerns and recommendations discussed earlier.

8. The following questions do not have to be considered LANDSAT specific, but can be viewed as pertaining to remote sensing from space in general.

(a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

The potential value and importance of land remote sensing from space were clearly recognized by the previous administration and reflected in PD-54 and the original FY 82 budget. It would seem that the current administration has not fully recognized this value, although I'm sure that the argument could be made that, given the magnitude of recent budget cuts, the system would not have survived at all were its importance and value not recognized.

(b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Government policy has failed to set the stage for an operational system by continually delaying the policy decision to go operational. Many users have been discouraged from investing in computers, staff and data by the lack of Federal committment and the experimental status of the system. A policy decision to eventually go operational five or more years ago would have today resulted in much more operational usage of the data and a much larger market across which to spread costs. Instead, we have been in a "chicken and egg" situation where potential users hesitate to become involved because of uncertain data continuity, while several administrations have hesitated to go operational due to limited user committments and investments.

In the twilight of the last administration this problem finally seemed to have been resolved. Now, however, we find ourselves back on square one making the same arguments and aiming for the same results we wanted four or five years ago.

PD-54, the Transition Plan and the original FY 82 NOAA and NASA budgets have been the most important policy decisions relating to the evolution toward an operational system. The recent cuts in the NOAA and NASA budgets, and the reluctance of the previous two administrations to commit to an operational system at some future time have been the most negative.

Representative FLIPPO. Mr. Anderson, thank you very much for your testimony and your viewpoint. I think it would probably be wise to have the testimony of Mr. Rado and then the members will direct their questions and perhaps seek response from either one or both.

If you would, please feel free to submit your statement for the record and summarize as you deem appropriate. Otherwise, proceed.

Mr. RADO. Thank you. Mr. Chairman and members of the subcommittees, I believe that my statement has been tendered to the committee and I'll just attempt to summarize and amplify a few points, if I might.

My name is Bruce Rado and I am the coordinator for remote sensing activities with the Georgia Department of Natural Resources. I have been involved with the Landsat program for approximately some 7 years. In addition, I am also the chairman of the Earth Resources Data Council of the National Governors Association (NGA). With me here today is Barbara Dyer, who is the associate director for Natural Resources at NGA.

We appreciate the opportunity to be here today and to share with you the Governors' prospectus on issues related to the operational civilian remote sensing satellite system and to reflect on private sector participation with regard to the system.

The States are rapidly moving to the forefront as the stewards of our Nation's resources. Through the decade of the 1970's, we experienced a national awakening towards the management of our natural resources. We recognize that energy resources are finite, that clean air and water are not staples but long-term goals, and that sustained productivity of our land cannot be taken for granted. This awakening resulted in a number of State and Federal programs and policies to develop our resource base without compromising the quality of our natural resources.

While demands for resource management persist, there are decreasing amounts of funds to perform these tasks. The States are now faced with increased responsibilities for resource management and fewer dollars with which to do the job. Therefore, the States are looking for a technology which can provide us with cost saving and the ability to get the job done.

Landsat and future remote sensing systems have the potential for being such a tool. However, unless and until we resolve once and for all that as a nation we are committed to space technology as a means for dealing with resource issues, satellite technology may be nothing more than a missed opportunity.

The uncertain future of land based remote sensing satellites has been a constraining factor in terms of State involvement in the system. Nevertheless, 25 States have developed the capability to analyze and apply Landsat data with investments of over $25 million and I think very substantial prospects for the future. Landsat has demonstrated capabilities in a spectrum of areas ranging from agricultural crop and irrigation inventories to flood and wetland mapping, water resource applications, major facility sitings, mineral explorations, et cetera.

To have a full appreciation of the increasing value of remotely sensed satellite data to the States, we need to look at the overall trend in State resource management technology through the use of these computerized information systems. With the projected advances in computer capabilities in terms of analysis, speed, and storage, coupled with steadily decreasing costs in equipment, the States are now able to handle tremendous volumes of data and engage in more complex calculations which we believe are very compatible with the Landsat system.

Further, we should look at the trend in other relevant data sets. The U.S. Geological Survey is producing 7½ minute topographic quadrangle maps in all digital form. Likewise, the Soil Conservation Service is developing soil maps on a statewide and countywide basis in all digital form.

As other data sets become increasingly available in this computer form, the hardware and software capabilities will improve and the value of Landsat will be further increased. As the Landsat system progresses, States and the industries operating within the States—and I'd like to make this point. Although I sit here representing the National Governors Association, the Governors are the individuals that I answer to and are also the individuals which corporate American talks about its resource problems. We should not lose sight of that fact.

I think it's important to note that States and industries will rely on this computerized triad of natural resource data comprising topographic maps, soil maps, and satellite data which will all be in digital form. This means that in coming years, corporations and State agencies will be looking to soil data, to vegetation satellite type information, and to topographic information, all in computerized form.

Due to the ambiguity surrounding the ultimate disposition of Landsat, combined with some inefficiencies in the system as it is currently set up, States may be unwilling to make such investments in Landsat. There must be assurances that an operational system will exist over time, that the system will produce reliable data in a timely fashion with equal access to the users.

If we are to contemplate a future for satellite remote sensing in this Nation, the Federal Government must provide some assurances whether the system be publically or privately operated.

As the States, we are concerned about the configuration and the reliability of the system. Whether it is publically or privately operated is only an issue as either option affects the nature of the system and its output. A publically operated system has advantages that it provides guaranteed access to all users. On the other hand, we are now all too familiar with the fact that satellite data in the public sector also can be politically and physically vulnerable to changes.

If properly constructed, a privately run system could have advantages. For one, it is likely to be a more efficient operation. However, it needs to be pointed out that the States are not yet willing to endorse any option for private sector operation until the terms for such an agreement have been laid out and we've had the opportunity to comment on them.

Some of the guidelines by which we would be willing to evaluate such a system would be that that system not have a negative impact for the launching of Landsat D, that the proposed system provide continuous coverage now and at the close of this decade, that the States be guaranteed access to the system, and that the pricing policies reflect the fact that in the States, we have 1- to 2-year leadtime in terms of our budget cycles.

The position taken by the Office of Management and Budget over the last several years suggesting that the users cover the cost of the system appears to be prudent. As it is implemented, it will be interesting to judge its success. The most frequently drawn analogy for transferring Landsat to the private sector is that of communications satellites. It has been said that the market for communication satellites was well established, and therefore, lent itself to private sector operation. The comparison between the communications satellites and land remote sensing satellites might be a little overly simplistic. It is important to recognize the differences between the two systems that exist.

Communication satellites are designed to enhance interaction among people. In this system, the process and the volume are the critical benchmarks. With satellite data, land remote sensing, the content is the important element. These satellites are designed to provide information, just as topographic maps and soil maps are designed to convey a content.

We would like to emphasize that whether the market can support this technology now or later, the technology must now move forward. However, we do not believe that market uncertainty should be a consideration as to whether we continue to develop our land remote sensing capabilities in space.

This system suggests that regardless of the extent to which we adopt a private sector approach, the system may require continued commitment by the public sector. These types of commitments, which I'm sure you're well aware of, could take the approach of Federal agency guaranteed markets, a regulatory framework to allow equal access, measures to sustain the system until market cost recovery is possible, and measures to assure continued operation of the system if cost recovery is not feasible in the private sector.

While it is true that a constraining factor with regard to using satellite remote sensing data is the current limits of the technology itself, its present capabilities have proved themselves operational in many States. Improved resolution in sensors will no doubt increase the marketability of the system.

However, we now have a proven low cost technology. If we couple this proven low cost technology with sound management, aggressive marketing, and flexibility to incorporate into the system, new technologies, as they are developed, we will be insuring a U.S. leadership with regard to this technology.

We believe that research and development must be aggressively pursued, as the subcommittee chairman has stated. This issue is critical in order to enable us to address our increasingly complex resources issues and to insure our leadership role.

The research and development agenda should combine the best elements of the public and the private sectors. This research agenda should be driven by real and projected national research problems. Further, a mechanism for transferring experimental technology to the users should also be available.

A mechanism must be developed which will enable users to provide input into the mechanism that is more than strictly symbolic. Beginning immediately and pending decisions about transferring the system to a private operator, a council of users should be established. The user council, which I trust will include the States, should have a very specific charter to determine recommendations on issues such as mission profile, pricing policies, frequency of data availability, and research and development.

If we move to an option of the private sector, user input could be structured in a number of ways. Whatever degree of private sector responsibility for operation is ultimately agreed upon, it is the role of the Federal Government to establish the guiding policies and framework.

In conclusion, let me stress that it is critical that the United States have an operational remote sensing system. If we allow short-range economic constraints to dictate in this case, the long-range implications could be devastating for this Nation. It is important that we focus on the policy implications of not having this technology.

While the Office of Management and Budget, through its aggressive economic reform program, has stated its budgetary position with regard to satellite remote sensing, it is time for the Administration to specifically focus on the policy implications. In particular, the administration should examine the economic and political importance of this technology in the international and domestic arena. Because the United States cannot afford to lose sight of the far reaching importance of this capability in space, we ask that this body direct the administration to focus on the issue and to present its findings.

I would like to stress that the States are most anxious for the operational land remote sensing system to be cost effective and successful. The States are prepared to be viable participants in this effort.

We thank you for your consideration.

[The prepared statement, plus answers to questions asked of Mr. Rado follow:]

TESTIMONY OF BRUCE Q. RADO

REPRESENTING

THE NATIONAL GOVERNORS' ASSOCIATION EARTH RESOURCES
DATA COUNCIL

to the

SUBCOMMITTEE ON SCIENCE TECHNOLOGY AND SPACE
OF THE
SENATE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

and the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
OF THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

Chairman Schmitt, Chairman Flippo, distinguished members, it is an honor to have this opportunity to appear before you to discuss potential directions for a civil operational satellite remote sensing system. I am Bruce Rado from the Department of Natural Resources of the State Georgia and Chairman of the National Governors' Association's Earth Resources Data Council. On behalf of Governor Busbee, Chairman of the National Governors' Association, and the Earth Resources Data Council, I am happy to express our views on this matter.

States are rapidly moving to the forefront as stewards of our nation's resources. Through the decade of the seventies, we experienced a national awakening to the importance of our natural resources. We recognized that energy resources are finite, that clean air and water are not staples but long term goals, and that sustained productivity of our land cannot be taken for granted. This awakening resulted in a number of state and federal programs and policies designed to develop our resource base without compromising environmental quality or the integrity of the resources for future generations. Federal legislation such as the National Environmental Policy Act, The Clean Water Act, The Resource Conservation and Recovery Act, and The Clean Air Act called for new sophistication in assessing and managing the nation's resources. In many cases, states have passed similar laws to establish programs for meeting their individual goals.

While demands for environmental quality persist, there is increased competition for federal funds to states for resource management. States are now faced with increased responsibilities for resource management and fewer dollars with which to do the job. The states are looking more for cost efficient tools that will help them to do the job. Landsat and future remote sensing systems have the potential for being such tools. However, unless and until we resolve once and for all that as a nation we are committed to space technology as a means for dealing with complex land resource issues, satellite remote sensing will be nothing more than a missed opportunity. →

WHY SATELLITE REMOTE SENSING?

The uncertain future of land remote sensing satellites has been a constraining factor in terms of state investments in the system. Nevertheless, twenty-five states have developed the capability to analyze and apply Landsat data amounting to an investment of over twenty-seven million dollars. Every year several additional states initiate a program involving remote sensing capabilities.① Landsat has demonstrated usefulness in agricultural crop and irrigation inventories, flood and wetland mapping, water resource applications, forest inventories, major facility siting, and mineral exploration. Over five hundred different management applications of Landsat at the state level have been identified.

Present state applications for Landsat are only a small indication of the potential use by states. It can be predicted that the greater resolution of future sensors will make Landsat fully applicable to a whole range of uses for which current resolution has only marginal value. Agricultural applications such as disease control and irrigation management will become increasingly important. Landsat will vastly improve our mineral exploration capabilities needed in order to boost domestic production.

To have a full appreciation of the increasing value of remotely sensed satellite data to states, we need to look at the overall trend in state resource information systems. With the projected advances in computer capabilities in terms of analysis, speed, and storage, coupled with steadily decreasing costs, states are able to handle increased volumes of data and engage in more complex calculations compatible to Landsat data. Further, we should look at the trend in other relevant data sets, since Landsat is only one component in a resource information system. The United States Geological Survey is producing new 7.5 minute topographic quadrangle maps in digital form. All existing topographic quadrangle maps are scheduled for digitization by 1992. Likewise, the Soil Conservation Service will have soils maps digitized on a statewide basis by about 1983. States have on their own begun digitizing soils maps as well. As other data sets are increasingly available in digital form and as software capabilities improve, the value of Landsat data correspondingly increases.

Due to the ambiguity surrounding the ultimate disposition of Landsat, combined with some inefficiencies in the system as it is currently set up, states may be unwilling to make further investments in Landsat.

There must be assurances that an operational system will exist over time, that the system will produce reliable data in a timely fashion, and that there will be equal access to data for all users. If we are to contemplate a future for satellite remote sensing in the United States, the federal government must provide these assurances, whether the system be privately or publicly operated.

WHO SHOULD OPERATE THE SYSTEM?

As states, we are concerned about the configuration and reliability of the satellite remote sensing system. Whether it is publicly or privately operated is an issue only as either option affects the nature of the system and its output. A government operated system has advantages in that it provides guaranteed access to all users. On the other hand, our experience to date has shown how politically and fiscally vulnerable a government operated system can be. If properly structured, a privately run system could have advantages. It is likely to be a more efficient operation. However, states are not yet willing to endorse any option for private sector operation of the system until the terms for such an arrangement are fully understood.

I offer the following as guidelines by which the states would evaluate any option that is to be considered:

- that the particular option have no negative effect for launching Landsat D in 1982.
- that the proposed system provide continuous coverage now and at the close of the decade.

- that the states be guaranteed access to the data
- that pricing policies and particularly change in prices be sensitive to state budget cycles (state agencies begin their budget process one to two years prior to receiving funds). If we precipitously increase the cost in this era of tight budgets, we can expect a proportional reduction in the volume of data acquisition.

CAN THE CURRENT MARKET SUPPORT A PRIVATE SECTOR OWNED AND OPERATED SYSTEM?

The position taken by the Office of Management and Budget over the last several years, suggesting that the users cover the costs of the system, appears to be prudent. As it is implemented, it will be interesting to judge its success. The most frequently drawn analogy for transferring Landsat to the private sector is that of communicaton satellites. It has been said that the market for communication satellites was well established and therefore lent itself to private sector operation. The comparison between communication satellites and land remote sensing satellites may be overly simplistic. It is important to recognize the difference between the two systems. Communication satellites are designed to enhance interaction among people. In this system, the process and the volume of use are the critical benchmarks. With land-based satellites, the content is the important element. These are designed to provide information just as topographic maps were intended in 1879 and soils maps in 1899. There is no question as to the value of topographic quadrangle and soils maps.

We want to emphasize that whether the market can support this technology now or later, the technology must move forward. However, we do not believe that the market uncertainty should be a consideration as to whether we continue to develop our land remote sensing capabilities in space. This suggests that regardless of the extent to which we adopt a private sector approach, the system may require continued commitment of public resources. These include:

- guaranteed markets through federal agency users.
- a regulatory framework that would assure equal access to data
- measures to sustain the system until market cost recovery is possible
- measures to assure continued operation of the system if cost recovery is not feasible as a private venture.

HAS ENOUGH RESEARCH AND DEVELOPMENT OCCURRED TO PROVIDE A SUFFICIENT TECHNOLOGICAL BASE FOR AN OPERATIONAL SYSTEM?

While it is true that a constraining factor with regard to using satellite remotely sensed data is the current limits of the technology itself, its present capabilities have proved themselves operational in 15 states and 10 others are in the process of developing an operational capability. Improved resolution and sensors will no doubt increase the marketability of the system. However, we now have a proven low cost technology. If we couple this proven technology with sound management and flexibility to incorporate into the system new technologies as they are developed, we will be insuring a United States leadership in satellite remote sensing.

I am reminded of the debate regarding the operational status of weather satellites during the 1960's. TIROS, the first weather satellite, provided the Weather Service with an immediate solution to the problem of delivering weather forecasts. While the TIROS technology was at the time perceived as lacking in the state-of-the-art and new advanced technology (NIMBUS) was being developed for testing, the Weather Service pushed hard for TIROS to become operational. This was done in 1966 in spite of objections that the technology was not sufficiently advanced. Nevertheless, it appears the nation has benefitted from this decision.

Research and development must be aggressively pursued however. This is critical in order to enable us to address our increasingly complex resource problems and to insure our leadership role. The research and development should combine the best elements of the public and private sectors. The research agenda should be driven by real and projected national resource problems. Further, a mechanism for transferring experimental technology to public agency users should continue to be available.

USER INPUT MECHANISMS

A mechanism must be developed which will enable users to provide input into the system that is more than symbolic. Too often advisory committees are established for national programs which prove to be nothing more than placebos. Beginning immediately, and pending decisions about transferring the system to a private operator, a council of users should be established. The user council including the states should have a very specific charter to determine recommendations on issues such as mission profile, pricing policies, frequency of data availability and research and development needs.

If we move to an option of private sector operation, user input could be structured in a number of ways. Whatever degree of private sector responsibility for operation is ultimately agreed upon, it is the role of the federal government to establish the guiding policies and framework for the system. Through legislation, standards guaranteeing equal access, fair pricing policies, continuous coverage and system reliability should be required. Users, including the states, must be actively involved in the process.

In conclusion, let me stress that it is critical that the United States have an operational satellite remote sensing system. If we allow short range economic constraints to dictate in this case, the long range implications could be devastating for this nation. Our access to critical information on resources within this nation and internationally will be impaired due to differing philosophies regarding continuous coverage. We cannont afford to lose sight of the far reaching economic and political importance of this capability in space to the United States. We stand ready to assist you however we can in assuring our continued leadership in the field of satellite derived information.
Thank you so much for having us here today.

THE COUNCIL OF
STATE PLANNING
AGENCIES

ROBERT N. WISE
DIRECTOR

September 24, 1981

Mrs. Terese McDonald
The Committee on Science and Technology
Subcommittee on Space Science and
Applications
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mrs. McDonald:

Attached is our response to the follow-up questions from the July 22 hearing. It is our view that the most critical issue to be addressed at this time is the apparant abandonment of a national commitment ot a civil operational land remote sensing system. The Administration has not focused on the implications of this retrenchment at the highest policy level. We have allowed all policy decisions to be driven by the budget process. This is a dangerous precedent. In our testimony on July 22 we asked that the Congress direct the administration to examine the implications of not maintaining our lead in remote sensing both domestically and internationally. To our knowledge, this has not been done. We feel that LANDSAT is ready for operational use. We do not feel that we have adequate assurance of timely and uninterrupted service through the late 1980's. It is our view that if action is not taken immediately, there is no certainty that there will be a system in this country at all beyond the late 1980's. This is critically short sighted.

I appreciate the opportunity to share our views with the committee.

Sincerely,

Bruce Rado

Bruce Q. Rado, Chairman
Earth Resources Data Council

cc: Tom Potts
Carol Lane

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COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

ERDC response to follow-up questions of the House Subcommittee on Space Science and Applications on Land Remote Sensing.

2. Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of LANDSAT system and whether the system should be operational now.

(a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

Landsat is now ready for operational use. It has demonstrated value for agricultural crop monitoring, irrigation inventories, flood and wetland mapping, major facility siting, and mineral exploration. Landsat is operational in fifteen states and ten additional states are developing operational capabilities.

(b) What is the applicability of LANDSAT D to an operational system?

The improved sensing and higher resolution capabilities promised by Landsat D will increase the marketability of the system. It is important that we build into any operational system the flexibility to incorporate new technologies as they become available. The current capabilities of Landsat are limited though important. Landsat D addresses some of those limitations.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

Given the current budget process there is absolutely no assurance that there will be any service through the late 80s.

3. Policy issues relating to the proper government/private sector relationships and the scope of the involvement of the commercial sector are in need of further clarification.

(a) By what process should responsiblity for remote sensing move to the private sector?

An equitable competitive process should be established. Major users should agree in advance on the minimum terms necessary for any owner operator to adhere to. It is important that this process not get bogged down in long drawn out irrelevant procedures however. Timliness is critically important.

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the question of finances)?

Yes.

(e) Is a copyright provision necessary for private sector operations?

A copyright provision would be necessary for private sector operations. It would be impractical for a private corporation to take over a system if the products to be sold were xeroxed and resold. There is no profit in having the system if there are no proprietary rights to the products.

(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

The concept of non-discriminatory data access is compatible with private sector involvement. A company can establish reasonable pricing policies and sell the data on an equal basis. While there is some speculation that a non-discriminatory policy would be a disincentive to private sector users, this is not substantiated. A policy of discrimination would have severe consequences. It would put public and private institutions against one another. It would also potentially put public agencies against each other. It is in the public interest to maintain a policy of non-discrimination toward the access of information. Decision making in the public sector has got to be based on reliable information. To impose contraints on our ability to develop the data bases needed to make sound policy choices is unnecessary.

(h) How should a private sector operator be regulated, if at all?

A regulatory framework should be established to guarantee equal access to data and to assure fair pricing policies. It should not be so prescriptive as to inhibit private sector interest in taking over a system.

5. Satellite data is being utilized to provide data for public services.

(a) How is the utilization of remote sensing data important to the public welfare and health?

Concern over deteriorating and/or diminishing resource supply has led to the development of policies and management strategies aimed at preserving the economic and ecological productivity of the resource base. Public agencies, as stewards of the natural environment have the difficult job of establishing balanced resource policies and programs in an arena characterized by conflict. Resource policy decisions have a reaching implications for public health and savety. They also have a major affect on the economy. Timing and accuracy of information is critical to sound resource decision making. Landsat provides one tool for addressing resource issues in a timely, reliable manner.

(b) To what extent are State and Local governments utilizing this data for public services?

(Refer to NCSL response)

(c) What are the primary concerns of the state governments (i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3? (ii) with the future commercialization of land remote sensing?

It is not important who runs the systems as long as it exists.

7. There is a need to clarify how remote sensing data could or should be priced.

(a) For a government-operated system, should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

A pricing structure should be established that is understandable, so that public users can project prices for inclusion in their budgets. There are a number of seemingly reasonable variations for pricing. The states would like to examine the alternatives and participate in the determination process.

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

Yes.

8. The following questions do not have to be considered LANDSAT specific, but can be viewed as pertaining to remote sensing from space in general.

(a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

The future of a United States Civil Operational Remote Sensing system is in grave jeopardy. This is due to the fact that there has been no consideration by the current administration of the policy implications of Landsat. The program has been lost on the shuffle to balance the budget. There is no current policy independent of the budget process. It is critical that some leadership be demonstrated to assure proper consideration of a US space remote sensing policy.

(b) How well have government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Government policy through its research and development programs has made an operational system feasible. However, it appears that the Government may be abandoning the effort just at the time when the system could become actualized.

RESPONSE TO QUESTIONS FROM SENATE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE

Hearings on Civil Land Remote Sensing
July 22, 1981

Bruce Q. Rado, Chairman, Earth Resources Data Council
National Governors' Association

1. When you say the states should be guaranteed access to the data, do you mean a policy of non-discriminatory distribution?

The states have maintained that guaranteed access to information should be a fundamental tenant of public policy. Guaranteed access is synonomous with a non-discriminatory policy. We consider information to be a public good. What is done with the information once acquired is solely up to the creativity of the holder. It should be noted that we are not equating public good with free good. We have no objection to attaching a fair cost to information.

If we were to adopt a policy of discrimination, then the attainment information would become subject to profit motives. This would place public access of information at a competitive disadvantage to the private sector.

The only advantage to a policy of discrimination is that some users may be willing to pay more for the data. However, there is no evidence suggesting that private and public users would not purchase or pay fair market value if a non-discriminatory policy were maintained.

2. The Commerce Department has stated that they have had discussions on pricing policies, have you been included in these discussions?

Commerce Department Pricing Policies:

We have not. States are committed to paying their fair share for data. However, we have not been presented with any concrete figures as to what this would cost. It would be useful to have information regarding the cost of the system (hardware) and the cost of the data. We could then develop options for financing that might more equitably distribute the costs of owning and operating the system.

3. Have you been participating in the User Workshops that have been conducted by NOAA? What has been your perception of your input into a policy decision?

   It is not clear that the Administration has made any policy decision regarding the future of LANDSAT. All policy has been dictated by the budget process so far. The question as to whether the NOAA workshops were successful is really moot. This Administration should be directed to focus on the policy implications of maintaining or abandoning our commitment ot earth resource satellites immediately. Otherwise LANDSAT, lost in the scramble to balance the budget, is nothing more than a missed opportunity..

4. Has your state organization been actively marketing remote sensing information? If so, please explain how you have done this.

   The Council of State Planning Agencies/National Governors' Association are not in the business of marketing or promoting technology. However, we do provide information to states on the availability and potential uses of LANDSAT. This activity has had the affect of increasing state use of LANDSAT.

5. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

   See number #1.

If we were to adopt a policy of discrimination, then the attainment information would become subject to profit motives. This would place public access of information at a competitive disadvantage to the private sector.

The only advantage to a policy of discrimination is that some users may be willing to pay more for the data. However, there is no evidence suggesting that private and public users would not purchase or pay fair market value is a non-discriminatory policy were maintained.

6. The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

An operational system would use reliable tested technology which would be less costly than experimental technology. An operational system might realize economies of scale by coupling with other satellites during the launch and sharing compatible sensors.

An agressive marketing program necessary for an operational system would build the user community. Presumably the costs would be reduced by distributing them among a larger body of users.

7. Are you aware of aggressive marketing by the French for SPOT data?

We are aware of aggressive marketing by the French for SPOT data. We are on their mailing list and have been solicited to purchase data.

8. What are your views on single entity operation of the system vs. competition for the various segments of the system?

This is not an issue that we have concerned ourselves with.

Representative FLIPPO. Thank you, Mr. Rado, for excellent testimony. I would like to focus a question and then ask for a response from either of the gentlemen who would care to respond.

In the typical use of Landsat data, do you use the data in the format that is obtained from the Government or is much analysis done on the data to obtain the information received?

Mr. ANDERSON. Go ahead.

Mr. RADO. I think both, to answer your question. I think you'll find that there's a great deal of work in the area of geologic-type investigations occurring with the data in its raw form. You'll find that there's a great deal of application occurring, let's say especially in forestry applications with the processing of data.

So I think we find that both occur—I don't know whether it's equal or not, in answering your question, but I think there are tremendous strengths which each one of the data sets, whether it be the preprocessed data or the already processed information, each has its own strengths, which, in combination, I think provide an even stronger system.

Representative FLIPPO. Could you give us any figures on how many States have equipment and staff in place for data analysis?

Mr. ANDERSON. Approximately 15 States are hardware-equipped at this moment and are making routine use of the data. Ten States are in active planning and workup mode for utilizing the information. Some have acquired some hardware; others are lining up their needs and working on plans and so forth.

So that you have 15 now using, equipped to use it in both forms, as Mr. Rado has said, and 10 actively working toward that.

Mr. TESSAR. Those 10 are funded and have staff in place that are currently developing capabilities, most of which should be operational in the next year.

I might add, regarding the character of the applications, digital versus the photographic, probably the majority of the applications do involve computer processing of the data, although there are some things such as geological applications or flood monitoring, which use the photographs. They're a little bit quicker, but also less precise.

Representative FLIPPO. Could you submit those States for the record at some future time?

Mr. RADO. Certainly.

Representative FLIPPO. Mr. Anderson, Landsat data is valuable if it's usually analyzed and the States have invested in analytical capabilities. Why do you say that you can't pay for the time cost of the data, which time cost of the data would probably be less than $1,000 per tape, or something along that line?

Mr. ANDERSON. The point I make, Mr. Chairman, isn't that we can't pay for the time cost. The point I make is that we don't feel that we can afford to pay for a developed portion of the basic capital outlay for the system in addition to time cost.

We are now and would continue to be happy to pay for data reproduction and distribution. If there were to be some incremental additions to those costs based on reproduction characteristics and factors, the States and other users, I'm sure, would be pleased to pay that cost also.

But the costs that concerns us are the R. & D. and basic capital costs. I think it would be deterrent to use of the system, whether it was acquired by private industry or operated by the Government, for the cost of the development of the hardware in space and related ground facilities, to be amortized by users at this time. I think that this would quickly deter further use of the system.

Mr. TESSAR. Mr. Chairman, if I might add, I am about to change hats and take another position to become head of the Arizona Land Resource Information System, and if I could, I would like to give you an example of one of the problems with the price increases. I have already had to submit my budget for the next fiscal year. It is fixed. Two years from now, I know how much money I will have for Landsat data, and that is $10,000. And if the price goes up five times, I'll buy one-fifth as much data.

There's just not an easy way to take care of these massive price increases in the short term.

Now some States also have biennial budgets. So they're looking at the next 3 years. The amount they have to spend fixed. And the price increases are important, but the timing is even more important. If we have adequate notice, it wouldn't be as big a problem.

Representative FLIPPO. I think you've answered that question. That is, indeed, a time problem. Mr. McGrath?

Representative MCGRATH. Thank you, Mr. Chairman. I get the impression from your testimony that you're not solidly behind at this point the intended transfer of this technology and use to the private sector. Am I right in that assessment?

Mr. RADO. I guess it's a double-edged sword. We've had a system now for 8, going on 9, years in this country where in some ways if you go to a meeting to discuss the issues of Landsat now, you might think you're in the "way back" machine back in 1974. Many of the issues in 1974 are the same today: We need an operational system with a commitment toward that system. To date, we have not gotten that commitment from the Government.

So I think in a lot of ways we know that the Government has provided a system. In the same regard, we have not gotten the operational commitment. And that holds down the user community. It reduces the amount of marketing, the amount of money that's spent in this area.

In the same regard, I think that the States are interested in the bottom line. Personally, I don't care who operates the system; just give me what I need in a manner that's sensitive to our concerns, such as budget and pricing policies, as Representative Anderson just stated.

But I think we are willing and able to listen to all considerations once they're placed on the table.

Representative MCGRATH. You've been given this information at a very reasonable rate up to this point. I can understand your concern regarding the transfer or the takeover by private enterprise.

However, in your testimony, you also mention that if we're going to go ahead with this thing, that the Federal Government ought to guarantee markets. And yet, one of the biggest markets for the information are local governments, the Federal Government itself, or some of the State governments.

I'm just wondering why the Federal Government should pay for that information if the States won't or can't?

Mr. ANDERSON. Congressman, in that regard, I'd like to say that I mentioned earlier that I believe the rightful position of the Government is to provide for the people that which they can't provide for themselves as efficiently. I think we have here an example of that kind of service.

The States can't possibly consider individually providing themselves telemetry from space. That's just not within the purview of reality.

So we would hope that the information provided by Landsat technology could be made available to us from the Federal Government or, for that matter, from private industry. We don't really care who owns the system so long as it's made available to us on a continuous, timely basis at a reasonable price.

We would hope that it can be made available in that regard and in that manner.

So we're not opposed to private industry operation of the system. We have some problems with the outright gift of the system to private industry, as may have been considered by some. But the operation, particularly, as I said, of certain facets of the program—such as the data processing system now in operation could easily be assimilated by private industry and reasonable costs of payment worked out.

Representative MCGRATH. Do you in Michigan operate under a system of user fees for services?

Mr. ANDERSON. In some cases, yes, sir, we do. We have user fees for a number of functions of State government, and in other cases, depending upon the nature of the service, we provide from the general funds of the State services that are needed based upon certain transient factors.

Representative MCGRATH. One final question. With this intended transfer, do you believe that the R. & D. element of this technology ought to be transferred to the private sector from the Government?

Mr. TESSAR. I think the communications satellite example that was mentioned earlier is probably a good one to allow certain opportunities to exist within the private sector, possibly, but to allow research and development to occur within agencies such as NASA.

I think one of the things that has occurred is that as the States have had the opportunity to deal in research and development with NASA, we are now feeding State experiences into the NASA R. & D. loop, which is assisting in the potential design of future systems to meet national resource policies.

Mr. ANDERSON. Mr. Congressman, I'd like to suggest that if we rely too heavily on the private sector for the provision of R. & D., we stand a greater danger of R. & D. being dropped as a secondary need.

In the case of the communications satellites, we saw some of this. The R. & D. attention was reduced because of the need for finding a way to pay for the overall system. So if you have a requirement that the system be profitmaking, and that it pay for itself, R. & D. must, of necessity, take secondary importance and we can become static at the level of which the technology was assumed.

Senator SCHMITT. Thank you, gentlemen. Let me make it clear, Mr. Anderson and Mr. Rado, that one of the reasons that the Senate committee became concerned 2 years ago, and I think one of the reasons why the House committee is also concerned, is if we look at past indicators, if we don't get this system out of Government, we may not have a system. This budget cycle has shown no change in that possibility: the President's request to eliminate two follow-on satellites.

Mr. Anderson, you expressed some concern that the States would somehow be hurt if there was a spinoff of this. I think we can probably insure that certain of your concerns can be worked out as safeguards in legislation.

But I don't think there's any basic reason why the States would necessarily be hurt by a spinoff into the private sector. Certainly, you were not hurt by the creation of Comsat and spinning off communications activities of that nature out of the Government.

So, I hope that you would agree that, provided there are certain safeguards, availability of data that you need, certainly value-added data, which you even now purchase from certain sources, then there would not be any inherent reason why the States would be hurt. And including cost of services.

Mr. ANDERSON. Yes. I didn't mean, Mr. Chairman, to convey the impression that we oppose the concept of transfer. We are not, from the standpoint of the State legislatures, opposed to transfer of the system to private control. Our concern is for the continuity of information, its timeliness, and the reasonableness of its cost.

Senator SCHMITT. Now one of the arguments that some of us make about the private sector situation is that it will probably increase the timeliness, the availability of data, and increase the variety of value-added data if we could just get it out of the Government's hands and into a competitive environment, where they can market to you and each one of them trying to satisfy your needs better than the other's. That's the key.

Now has there ever been any quantitative or even qualitative estimate of the value or the increase in State revenues as a result of use of remote sensing data by the states?

Mr. ANDERSON. I'd ask Mr. Tessar to give specifics on that, Mr. Chairman. I don't think that we look at it as a means of improving the income or revenues of the States. We've used it in several States which we've examined as a means of providing better information, quicker information, at less cost than was formerly possible.

Senator SCHMITT. What I'm getting at is the use of that information that you have provided by the private sector, agriculture or otherwise, presumably has enhanced the return of their activities, which, in turn, is enhanced.

Mr. ANDERSON. In that context, sir, I'm not aware of specifics. Perhaps Mr. Tessar is.

Mr. TESSAR. I don't know if there has been any quantitative or qualitative studies, but there certainly has been some dollar benefits to the States, such as in Washington State, for example, they are considering setting up a system to monitor the clearcutting of forests to make sure that people pay their tax on time and on the right acreage clearcut. If when landowners roll tax payments over a quarter, that costs the State money. And if they can catch them right as they're harvesting and assess a penalty for the quarter delay or whatever, there is definite dollar impacts.

Many of the applications, however, don't have a direct economic benefit. What is the value of less soil erosion on some land, or a stream that's clean enough to support trout? So many of these things are environmentally related.

Senator SCHMITT. I can cite qualitative value contrary to both of the examples that you just gave.

Mr. TESSAR. That's true. They have a qualitative value.

Senator SCHMITT. I mean that it's just going to be hard to put a number on it. But clearly, there's an economic value to maintaining land for agricultural purposes or development purposes otherwise. Clearly, there's a value to adding streams that people are attracted to as tourists and fishermen.

Mr. TESSAR. That's true.

Senator SCHMITT. If nothing else, they buy more State fishing licenses.

Mr. TESSAR. That's true. I guess the operational use of the technology is only a few years old and there really hasn't been enough opportunity to make those kinds of studies.

Regarding the private sector question and the transfer, our only real concern is that the private sector tends to cater to the largest users. State and local government really is only 10 percent of the market for Landsat data. From a strict data purchase volume standpoint, we're not that large a user. In terms of the public policy significance of those applications, however, it far outweighs the actual dollar volumes of the data in terms of managing our resources, preserving the environment for future generations and allowing the State to do its job in a more cost-effective manner in those areas.

Senator SCHMITT. I'll follow up in a moment. Mr. Lowery?

Representative LOWERY. Thank you, Mr. Chairman. Mr. Rado, you said the Landsat activities at Georgia Tech are extensive. You do a very fine job.

Senator SCHMITT. If I may just interject, you're absolutely right. I've seen the work that they've done. It's one of the outstanding efforts in the country.

Representative LOWERY. Could you describe exactly what you do do with the data at Georgia Tech?

Mr. RADO. What we have established in the State of Georgia is an arrangement where the State agency users acquire, through cost, services through the Georgia Institute of Technology, which has a full Landsat processing system and is, recognized as one of the groups that has been a leader in this area for quite some time.

All of the State agencies come through the department of natural resources, which I am in. And basically, what we operate as at DNR is kind of the coordinator of State activities. One of the types of activities that we maybe should be doing, in answer to Chairman Schmitt's recent question, is now that we've gotten past the "gee, whiz, I think I can use this" stage, is States have a responsibility on our own to go to the other individuals throughout the State and to say, we've got a technology for, let's say, tax assessment purposes could be used to help increase the revenues due to a particular government. And as that type of capability increases, there's no reason why the States could not afford to pay a little bit more money for data acquisition, for equipment, and to build up our own capabilities, as we help, not only State agencies, but in our example, we work with some of the industries within the State. They may not ask us to process their data, but they surely come to us to say, well, if we're going to run a powerline from point 1 to point 2, tell us about this Landsat that we've been hearing so much about.

And the learning curve is the whole issue in this particular discussion. What industries are hearing about now might be things that we did 3 years ago. Just like in answer to the number of systems that exist in the States, the number may be 15 or 25 right now. But as the cost of the systems are coming down and the learning curve is going up, it could be 50 or 100 in another year, because systems are starting to cost $40,000, $50,000, $60,000, as well as a quarter of a million dollars.

I think that what we do at the State is an educational learning experience for other State agencies and the private sector, as well as our own projects and other people's projects.

Representative LOWERY. You now primarily provide the services to, let's say, forestry, crop production, and like activities.

Mr. RADO. We are providing information to, as an example, forestry activities in the State.

Representative LOWERY. Who funds the Georgia Tech Landsat?

Mr. RADO. The users.

Representative LOWERY. Totally, the users?

Mr. RADO. Basically, that is correct. If I have so much money in my budget and I need to perform an application, I go in there and ask them to help us do some research and development in how the system could be used.

Representative LOWERY. So you, in essence, sell the services on a user basis.

Mr. RADO. Basically, that's the case, and it tends to be fairly economical in that rate. However, there are other States who have actually purchased equipment, set up systems, and allowed the agencies to walk in and use the system because it is sitting there.

Representative LOWERY. Well, of your total costs in the program, how much of it is acquiring the information from the Federal Government? What's the percentage? 5 percent? 10 percent of the overall cost?

Mr. RADO. I would say that it's certainly not one of our more expensive costs.

Mr. TESSAR. Less than 5 percent.

Representative LOWERY. Less than 5 percent. I have a problem there. There's a wee bit of a paradox. On the one hand, I hear that it's quite valuable, the information that you're getting; yet the States aren't willing to pay for the cost of data. On the other hand, you want it free, or as close to free as possible from the Federal Government; yet, you all sell the data.

How can you have it both ways? I think the chairman made a very good point. With the fiscal austerity that we're experiencing, we may not be able to provide the data. It just strikes me that we're just scratching the surface in terms of benefits. Aside from the qualitative aspects of water quality, there's a definite quantitative aspect as well because it's probably not necessitating using tax dollars to meet air and water quality standards, as we're able to do it in a far more efficient manner using Landsat data. That's moneys that local governments, State governments are saving that would not have to go into some large reclamation programs, in other words, to make the standards.

Mr. RADO. I believe what you're saying is accurate. In my statement, the point that I was trying to make with regard to pricing policy is that if you plan on increasing the cost five-fold or ten-fold in the next few years, just be aware that my budget next year, is finite and I can only purchase how much money I can get or I have.

Representative LOWERY. If you're going to do it on the user-fee basis, you're going to pass those costs along to those using the services.

Mr. RADO. That is true, but their budgets are fixed right now. But that doesn't mean in the future that we cannot absorb increases, because we're prepared to do that.

Representative LOWERY. Ultimately, somebody's got to pay the bill.

Mr. RADO. That's correct.

Mr. ANDERSON. Mr. Chairman, I don't want to leave a false impression here that the States are profiting from the use of the information. We have prepared a survey showing the time mechanism, ways and procedures in which the States have heretofore used the information that we obtain. Of course, we have to get the information from the Federal Government. That's its source.

But I don't think that any State can be said to be in a profitmaking position from the information. They may charge the agency budget for the information that they get from DNR. They may charge agriculture because DNR is the controlling agency within the Government.

The talk of cost increase implications that we've heard in the conversations and reports that have been seen is 5 times, 10 times, 20 times or more its present cost. Those are the things that concern us, not whether we have a reasonable cost increase or pay a reasonale fee toward the acquisition of information.

Senator SCHMITT. Chairman Flippo?

Representative FLIPPO. Mr. Chairman, I'm far more interested in your follow-up than my question, so I'll yield.

Senator SCHMITT. Mr. McGrath?

Representative MCGRATH. I'll yield also.

Senator SCHMITT. I wanted to get back to the question of value-added data and what is the proportion or some examples of how you have taken raw, preprocessed data and used it yourself versus contracting or purchasing value-added data as, say, in the Georgia examples.

Mr. RADO. Just a few years ago we had an effort where about 7 or 8 State agencies chipped in some rather limited resources to process the whole State. Some of those activities ranged from wetland identification for the potential acquisition of wildlife management areas to the delineation of the number of acres of forest types within various counties to water quality studies to assisting in information for industrial site location, irrigation studies, et cetera.

So I think the way in which these projects are evaluated is basically one in which the user community within the State is able to provide the information. I don't know if that answers your question.

Senator SCHMITT. Do you actually contract for value-added services? Does a contractor run your operation, or what?

Mr. RADO. No. What we basically do is come up with the cost recovery number that it takes for, let's say, our people at Georgia Tech and our people at the State agency to basically break even. See, what we're dealing with——

Senator SCHMITT. But you're the one in your institute that are adding value to the data. You take the basic Landsat computer-compatible tapes or whatever other information you have and you add value to it. You don't go out and purchase that added value from some company, company X or company Y.

Mr. RADO. That is correct, even though that option also exists for any State agency who wishes to do that.

Senator SCHMITT. Now Mr. Anderson, can you address that?

Mr. ANDERSON. Mr. Tessar can address himself to that.

Senator SCHMITT. Can you address that issue nationwide?

Mr. TESSAR. Yes sir. Most States, as they have chosen to adopt Landsat technology, have developed internal capabilities to process the data and add value to it. They've bought computers and color display monitors to work on the data and their use is internal, for the most part. Now those States often will contract out with the private sector, for example, to produce final output colored maps from a firm which has a specialized $300,000 piece of equipment and sells services on it.

So the operational systems do use services in that respect and they do consulting with experts in different areas, often in the universities, on the land surface features and things that they ought to be looking for when they're classifying those data.

The largest value-added uses in the States have been one-time applications where, for example, the State of North Dakota wanted a complete land cover analysis of the State, but didn't want to set up their own capabilities on a computer and wanted the entire job done in 14 months. They contracted out with Bendix and got the job done.

Many one-time projects, perhaps a 208 water quality studies or whatever, have been contracted out. When the use gets serious in a State, however——

Senator SCHMITT. You mean repetitive.

Mr. TESSAR. The repetitive use, a computer is purchased and the color display and full-time staff is brought on, in some cases, that service is provided to other State agencies on an as available basis with no charges involved. In some cases, the systems are moving toward becoming self-supporting and assessing user fees.

I would assume over time most State agencies, as they become established and as the users begin to flood the system, will start assessing fees as a way to prioritize the projects. As was pointed out earlier, there's an infinite demand for free services, and that goes for State Landsat processing systems, as well as anything else. And also, the State legislatures like to see these services develop a pay-as-you-go basis. After 3 to 5 years, many of them are beginning to look in that direction.

Senator SCHMITT. Is there any reason why the repetitive services are generally not provided by an outside contractor?

Mr. TESSAR. Well, there are several reasons. One is just the difficulty of working through the State purchasing bureaucracy every time you need to have something done. States don't have support contracts like the Federal Government does, where a contractor is brought in for a few years and is responsible for doing the job. It's a piecemeal, project-by-project basis.

So just working through all the bureaucrats can be quite lengthy and quite a pain and it may take as much staff time as just doing the whole job yourself. Also, it's more cost effective. When you've got your own staff that are familiar with local ground conditions and the land, they can analyze the data much better.

See, the interpretation of Landsat data and the value-added thing is not just a matter of pouring the data into a black box and getting something out the other end. It's really an art. The data you select for the data and how you analyze it determine what results you get. The more familiar someone is with the piece of ground that they're analyzing, the better their results will be.

So the States are hiring in-house staff that are familiar with the local conditions and know-how to analyze the data.

Senator SCHMITT. So you're just saying that so far, the offering of value-added services by the private sector hasn't included the art. It's included the mechanics, but not the art.

Mr. TESSAR. A lot of it. That's been some of the criticism of the value-added services, is they pour it in their black box and get a product out of the other end. They just don't have that feel for the local conditions that someone there might.

Senator SCHMITT. Apparently, your experiences in the States is similar to that in the large corporations, where they have tended to do the work in-house rather than, as I understand it, contract it out.

Mr. TESSAR. Yes.

Senator SCHMITT. Of course, there's a proprietary aspect to that also. Large industries, corporations, like to keep their own processes secret.

Mr. Lowery?

Representative LOWERY. Mr. Chairman, just one comment and then one quick question. I can appreciate the budget restraints that the State and local governments are under and your users are under. I just hope that you can understand that we're under the same restraints. Unless we have the information at its source, the whole system grinds to a halt.

Along the lines of Chairman Schmitt's questions, it would strike me that the large cost to build up some of the equipment and the computer analyzing and staffing, such as occurred at Georgia Tech, if you were to contract out for the private sector and were able to buy various Landsat services, couldn't we be avoiding an awful lot of duplication throughout the country by having all of that information gathered in a rather manageable form so that, ultimately, the overall costs are going to be lower than having the 50 States create it in-house?

Mr. **Anderson**. Bruce, do you want to deal with that first?

Mr. **Rado**. I'm really not totally certain of the answer to that question. I think that part of the reason the States have been as out-front as they are is the universities, and it comes back to Chairman Schmitt's questions. The universities, especially, are willing to gamble because it's research and development. And as the States are able to generate activities within that, as we did in our State, we were able to come up with some money to help that university recoup some of its costs that it did go out on a limb for.

So I think that's, in part, why the States are doing things in the manner in which they're doing them, keeping them in-house, because you feel that somebody went out on a limb for you 2 or 3 years ago to purchase something that you said you needed, maybe there's some allegiance that you owe to them, not to mention the cost-competitive nature of doing it in-house.

Mr. **Anderson**. Well, Mr. Chairman, Mr. Tessar has several years of experience in dealing with all the States in this area of Landsat usage, in addition to which he worked in one State on the subject of natural resources information and the use of this kind of telemetry. So he may have some perspectives on that also.

Mr. **Tessar**. I think the direct answer to your question is no. The main reason is that many States, in addition to developing Landsat processing capabilities, are also developing natural resource information systems to bring in many data sources, together in one data base and information processing system.

Landsat is just one layer. While they're buying the computer, anyway, they spend another $50,000 or whatever, to get a color display and a little software to work the analysis into the whole system. But for a lot of reasons, those are internal State functions. In terms of processing the data, would you really want to have a contractor doing a wetlands analysis to help determine what wetlands the State should be buying in a wetlands preservation program, or is that information somehow going to get out to the wrong channels and be abused?

Or would you want a contractor monitoring timber harvests for tax collection purposes? These are legitimate governmental functions and need to be performed on an individual State-by-State basis. As long as the systems are being developed, it's a small incremental cost to add the Landsat capabilities to that.

Senator **Schmitt**. Gentlemen, we probably should move on. But let me just see if part of the summary of this discussion is that the key question the States would face if the broad preprocessed data provision was spun off in the private sector, would be the cost of that data. That, otherwise, you could interact with it the same way that you interact with it now.

Mr. **Anderson**. That's correct.

Senator **Schmitt**. It's the availability, the timeliness of its availability, which, unfortunately, isn't very great now under the government program, and the cost. Those are the issues that I guess we ought to address as we look at this subject.

Mr. **Anderson**. That's correct. I'd like to make a final point, if I might, Mr. Chairman. In my testimony, I divided the system into several parts. The space hardware we worry about if we had to pick some cost of that because it's so great. It just isn't going to be economical for us.

However, the provision of the information derived from that system, in all of its aspects, is something I think we legitimately should pay for. Whether it be Federal or private, we don't have any serious concern. You've stated that the real concerns are timeliness, availability, continuity, and so forth.

Mr. RADO. I think there is one final point, though, Mr. Chairman, and that is that the design of the system configuration that the States are interested in is something that runs the gamut from being able to detect vegetation-related information to geological, et cetera, et cetera, et cetera. And if a system were designed to only do one small part, it would, therefore, only be able to assist that particular audience in the State government, let's say the geologic community—at the expense of the forestry and the tax people.

The design of the system is also something in the course of interest to us.

Mr. ANDERSON. May I make a point again so that it doesn't get overlooked, and that is that of the total user community, the States really represent a small segment—perhaps 5 percent, someone said. The oil companies, industries of all kinds, can make greater volume use of this information than the States themselves.

It's possible, if private industry is not channeled correctly in its outlook, that the needs of the State and the people of this country represented by the States could be overlooked in the overall planning aimed at the other 95 percent.

We're concerned about that.

Senator SCHMITT. That's possible. But in my conversations with the user industry, if you will, they are always arguing for greater flexibility, more spectra looked at, than arguing for some narrow spectra. They don't know where they're going to go next in the use of the data and they just want to have as broad a data base as possible. They'll do the value-added work internally.

So I think, in a sense, the development of this science or art, depending on how you look at it, is going to protect the States from that kind of a problem. I just have seen no tendency, and I don't know whether my colleagues have, either, for there to be a narrowing of interest in particular spectra or particular focus types of operations. It's all been the other direction: Let's get as many bands looked at as possible, as many different sun angles as possible.

Mr. ANDERSON. Mr. Chairman, on behalf of the State legislatures of this country, we appreciate your interest in calling this hearing and addressing this question. We consider it to be important in a very useful new tool.

Senator SCHMITT. Thank you, gentlemen. We appreciate your time and we'll be back in touch with you. We will try to get you to answer some questions for our record.

The next witness is Dr. Norman MacLeod, president, American Science & Technology Corp. We had hoped to have Stanley Morain, president, EarthScan International, but as I understand, he coud not make it.

Doctor, welcome. Proceed with your testimony, either in summary form or as you see fit.

STATEMENT OF DR. NORMAN H. MacLEOD, PRESIDENT, AMERICAN SCIENCE & TECHNOLOGY CORP., ACCOMPANIED BY DR. MURRAY FELSHER, VICE PRESIDENT, AMERICAN SCIENCE & TECHNOLOGY CORP.

Dr. MacLeod. Thank you, Mr. Chairman. Senator Schmitt, Congressman Flippo, and members of the subcommittees, the American Science & Technology Corp. (or ASTECH) is very appreciative of this opportunity to present our views on the institutional arrangements and timing for operations of the American Civil Land Remote Sensing System. Dr. Murray Felsher, who is with me this morning, vice president of ASTECH, is formerly Chief of Geology and Energy Applications at NASA, and I are very pleased to discuss the American Science & Technology Corp.'s private sector Earth observation program before this joint hearing.

The ASTECH program is predicated on private sector operation of commercial space systems, owned and operated by American industry, not the American Government. The ASTECH program is also based upon continued research and development in NASA, the Department of Commerce, and our Nation's university research community.

The development of the ASTECH resource information program—from data acquisition to complex resources discovery and joining of the historic, yet revolutionary trends, the conjunction of adequate space technology and emerging scientific knowledge about resource management. We feel that these are remarkable opportunities for the re-establishment of the primacy of American space technology and information science in the context of the solution of some of our most pressing problems—those of the discovery, evaluation, management, and just, equitable distribution of natural resources, especially those related to food, fiber and energy production.

We call our system FOODSAT/PETROSAT because it is designed to acquire and provide information about the management of these resources. We are aware that millions hunger, for example, not because of lack of land, but because of inadequate use of local resources and inadequate access to those resources.

We, as Americans, need more than will to remove, for example, our dependence on nonrenewable foreign energy resources. We need as well information resources which are focused on the discovery, evaluation, management, and distribution of these resources. It happens, Senator Schmitt, that you and I and many of us at this hearing have developed both the tools and the means of using them. The most cost-effective means of deploying these tools operationally is through the private sector, and I would like to discuss how ASTECH is approaching this opportunity.

In ASTECH, we are molding existing technology—sensors spacecraft, ground stations, and data processors—into the ASTECH resource management information system so that we and other nations can use such tools, in the words of the Landsat motto, "for the benefit of all mankind."

The space component of that system consists of several small satellites launched in Sun-synchronous polar orbit by small launchers to produce many observational opportunities in morning and afternoon passes. On-board data processors will encrypt data for direct broadcast to existing Landsat stations here and abroad. The on-board computers will also manage selection of spatial and spectral resolution. But we will, in the main, output the Landsat MSS data format that we have come to understand and use so effectively.

Not only have we come to use this specific type of data for resource management, but nations around the world have built their resource management and development systems on these data. Especially the developing countries, the LDC's, which have no other alternative data sources. With the United Nations support, these countries represent the largest current operational market for our products.

We are not only using existing technology; we are addressing the needs of an existing market. This market is affected by economic factors, as is any other. If our product is too expensive, it won't sell. Despite its elegance, it won't be used. This is not a Rolls Royce market, but a Model T market. We must produce a cheap, utilitarian product for every man—that is to say, every nation. Otherwise, as in the case of the automobile, others will do it for us, France with the SPOT, Germany with the ERS 1, the Japanese with the ERS.

In this highly technical enterprise, industry and Government have to work together. Our industry needs, must have, Government support, but not in the form of guaranteed markets or grants or subsidies. However, we need the assurance that we will not face competition from our own Government, either directly, as highly discounted Landsat D or D′ data sales, or indirectly in the form of discounted sales of Government assets and technology to quasi-public corporations.

The private sector can find an adequate return in the present free market because we can mount an effective program at approximately an order of magnitude less cost. If Landsat D or D′ costs $250 million, we can mount a more effective operational program at $25 million and we are on the way to doing so. However, if Government opts to compete with us, our efficiencies, innovations, resourcefulness, and dedication will go for naught. That's the negative side of this case.

While we don't require Government financial support, we do require support in other areas; principally, in the areas of international treaties and accords, of international marketing through embassy support during visits to foreign capitals, of vigorous technical support in technical forums around the world, and in the continued program of basic and applied research in Government and universities, as well as continued training of the magnificent science and engineering communities which have launched all mankind into the space age, the electronic age.

We also need the assurance that our Government will not be our chief competitor.

Senator Schmitt, Congressman Flippo, from these remarks you can discern the pattern of our ASTECH program. We are proceeding with the development of a low cost, technically advanced civil land remote sensing system which will supply an existing market at its current technical level and at its current capacity to buy our products. These products are demonstrably needed to inform all of us on the means of natural resource management.

We are not afraid of competition in this market as we are reasonably assured that our technology is currently as efficient as any. We are concerned about Government competition, direct or indirect. We hope the Government will purchase our products—for AGRISTARS and similar programs—but we don't depend on it. Instead, we depend on our Government to assist us in telecommunications, broadcast frequency assignments for our direct downlinks, in continuing the vastly productive R. & D. programs in Government and industry, the experimental satellite projects, the technology transfer and other training programs.

In the future, we see other space systems related to resource management moving into the private sector as they become operational. ASTECH is planning for participation in such programs.

We recognize the need for licensing of the private sector working in areas of public services—to meet treaty obligations, to assure Government requirements for data are met, and to assure the national defense and the security of our country.

In these senses, we welcome regulation. But gentlemen, as I've said, we in ASTECH are proceeding with the private sector development of our commercial Earth observations systems. Timeliness is important; indeed, vital to us. We hope that we can be assured that the development of regulations for this new industry will be done with dispatch as well as with regard to establishment of a strong American industry in the international market.

Senator Schmitt and Congressman Flippo, Dr. Felsher and I certainly thank you and your fellow members for this opportunity to make opinions of the American Science and Technology Corp. known to you. We would like to introduce additional information into the record, if it's to remain open. And we would be happy to respond to any questions that may have arisen.

Thank you very much for this opportunity.

[Response to questions from Senate Subcommittee on Science, Technology and Space by Dr. MacLeod follow:]

1. You mentioned that you intend to use existing Landsat groundstations here and abroad. How do you see this impacting our current policies?

#1. The existing policy of establishing, through a memorandum of understanding between US/NASA and the ground station operating state, an annual fee structure to be paid by the receiving state, a requirement for NASA access to data with data delivery upon NASA's request and the sale of data to all who wish to purchase at reasonable prices would be modified in ASTECH's commercial agreements with existing ground station operators. ASTECH will charge an annual fee for each spacecraft from which data is received by a station. With a four spacecraft FOODSAT/PETROSAT system there might be a charge of $250,000 per year for each spacecraft's data, or $1,000,000 per year for any one station, to use illustrative numbers. ASTECH would require access to or delivery of data under special terms where the operator and ASTECH mutually benefited from such access (for precision processing of data by ASTECH for example). ASTECH downlinked data received by its customers will be encrypted and thus not directly available to other customers stations in the receiving area. Those stations funded in part by the United States or by the United Nations would be expected to fulfill their obligations to those parties concerning data distribution, access and sales, but ASTECH will consider the received data to be the property of the receiving ground station operator. In contrast to previous arrangements which have been entered into between sovereign states, contracts between ASTECH and the receiving station operators will be commercial agreements lacking the flavor of treaties. In particular, while ASTECH is very much in favor of open distribution of data, has even degraded the possible spatial resolution of its sensor to make its output compatible with UN resolutions on the matter, we are not in the position to compel states to continue to hold to the open distribution policy. Of course, the United States federal government is in that position and could, under the open skies treaties, require that ASTECH contracts contain appropriate language. We feel that open distribution of data is in the interest of the receiving countries; we would endeavor to mainain the data catalogues which are proving to be so very valuable to remote sensing users around the world.

2. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy.

#2. One of the principal advantages of not distributing data to all purchasers is a psychological one; a sense of security is built up in which one nation feels that it is preventing another from observing its territory. In our view, this is an ostrich's view - the data will become available to the would-be purchaser sooner or later, but without the benefit of friendly commercial and technical relationships. It may be the case that an area has not yet been covered by Landsat data - such as some parts of Africa, Asia and Latin America. Countries not yet covered in total may feel more secure if data is not openly distributed. We cannot state that this is either a protection or a positive move in the direction of protecting the sovereignty of a state. In other words we cannot support the argument that "natural resources have the character of absolute sovereignty, and that earth observation missions violate that sovereignty in relation to international law." (Brazilian delegate to the UN Committee on Peaceful Users of Outer Space, 1975.) Under the UN treaties and resolutions, the nations can fly earth observations missions, especially if the spatial resolution is greater than 50 meters. It is also recognized that any ground operations on national territory consequent upon satellite observations will be fully under the control of the state in whose territory the ground truthing mission is to be undertaken. Perhaps the best action a state can take is to make sure they are in a position to exploit the earth observations technologies to their own advantage by taking up the many programs of training and advice available to all countries through the UN and many donor agencies.

Withholding of open distribution for commercial, not security, purposes, may have a temporally limited virtue. However, as the American oil and mineral industry has found, it is their own precision special processing of data that reveals the most commercially valuable information. Again, a determined searcher will sooner or later find out the information; it is better there should be productive, amicable commercial relationships.

Open distribution of data has other positive values; the management of natural resources usually operates at several mapping sacles. Those of earth observations and meterological data (1:1,000,000 to 1:80,000,000) are the scales of major resource systems, such as drainage basins, mountain ranges and estruaries. Very frequently these are international in scale, and represent international resource management scales. As this is so frequently the case, we find that Landsat data itself has an international character which is flawed (in use) by withholding data. On the other hand the open distribution of data has often served to provide a common technical basis upon which ~~solutions to~~ politico-technical problems, may be solved.

3. The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

#3. In an operational spacecraft earth observations system, cost reductions vis-vis experimental systems are available through use of proven advanced technology that is inherently low-mass, such as MLAs instead of MSS and TM technology. The use of direct downlink instead of on-board recording, reduces both mass and power requirements. Using sensor corrections for attitudinal-excursion corrections in addition to or instead of an active systems using consumables not only reduces weight but also increases lifetime. A fully integrated system in which the spacecraft, ground stations and data processors are optimized in relation to one another also reduces power requirements and costs. Significant savings in weight provide the opportunity to substantially reduce launch costs. Taken altogether we find available technology can be used to reduce costs by a very large factor.

In addition, the operational nature of the space system means that a production line can be maintained and updated as required by technological advances. An experimental system, but its very nature, is always a custom program. Just as the Model T Ford was far cheaper than its predessors, so is the FOODSAT/PETROSAT system cheaper than Landsat.

4. Are you aware of aggressive marketing by the French for SPOT data?

#4. The French government has recently appointed a distinguished firm for market representation in the USA (Earthsat, Bethesda, MD.). This is in addition to their appointment of Grumman as their representative for Ariane, the French and perhaps the ESA launch vehicles. The French have also concluded a 75,000,000FF loan agreement with the Peoples Republic of Bangladesh for the construction of a major ground station for SPOT (and Landsat), the provision of advanced image processing facilities for SPOT and the training of the Bangladeshi cadre. The French government also makes sure that SPOT representation occurs in technical meetings about the world with ample supplies of technical materials and well-qualified staff. In addition, highly qualified market research firms are conducting a market research program for SPOT. Additionally, M. Monet, speaking of French and European earth resources programs, is quoted in Nature magazine as being for exclusion of the Americans from the European technical market in remote sensing. Thus, in many directions the French are indeed agressively marketing SPOT. We feel that the SPOT system can be improved upon, and indeed that the FOODSAT/PETROSAT sensor/spacecraft system represents a distinct system improvement.

5. What are your views on single entity operation of the system vs. competition for the various segments of the system?

#5. A single entity operation of the US earth observations system should only result from early market conditions. It may well be that ASTECH becomes the sole US operator of an earth observation system (until Landsat D becomes operational). We have not sought nor do we seek a monopoly position guaranteed by the Federal government. We believe that we have a competitive position and can hold that position due to our particular knowledge of the marketplace, our management approach and our experience with the initial application of proven advanced technology. It is already true that the "value-added" or processed data sector of the market is highly competitive, rapidly growing and well outside the need for government support or review. The flight sector requires perhaps two orders of magnitude more investment than the value-added sector and will therefore have fewer entries. We feel that several firms can and should compete in all sectors of the program, that is in the national interest to do so, to develop and maintain preeminence in the field, and that a monopoly operation, far from being in the public interest, should be prosecuted for restraint of trade. We also feel that the transfer of operational responsibility from public to private sectors is not accomplished by a restrictive transfer to a quasi-public corporation.

Senator **Schmitt**. Thank you. The record will be open for a time. Chairman Flippo?

Representative **Flippo**. Thank you, Mr. Chairman. Dr. MacLeod, you state that you have developed a new satellite for $25 million. Could you tell us if such a program would be, say, 10 times cheaper than the current satellite, such as Landsat D? And could you tell us about the product of that satellite? Would it be multispectral and as many different spectrums as the Landsat?

Dr. **MacLeod**. Congressman, the $25 million figure comes from the use of existing technology, retrofitting existing technology. Some of this technology has been developed by NASA. Some of it is from other Government agencies. It involved retrofitting, for example, sensors that have been developed by NASA using MLA technology, as well as coupling those with existing small satellites that can be launched by small launching systems.

It's by this means that we are able to achieve the efficiencies. I should point out that we're not talking about an experimental system. I think that a great deal of the cost of the Landsat program arises from its experimental nature, particularly the thematic mapper being put with an MSS system in a newly configured spacecraft.

Where we don't have to develop such spacecraft systems anew, we have a distinct cost advantage.

The sensor product, the output of the spacecraft systems, is designed to be exactly the Landsat MSS product that we're all familiar with now. In our design development of the sensor system, we are including, however, other spectral regions which we hope in the future will be able to match the thematic mapper output as well.

But our prime design objective is to output Landsat MSS data which can be received by existing Landsat ground station systems so that there will not have to be any redevelopment or reinvestment in the ground station component or in the image processing component.

Representative **Flippo**. Has the corporation developed any of these smaller systems that you referred to—lower cost launch capabilities?

Dr. **MacLeod**. This is a very new corporation.

Representative **Flippo**. I see.

Dr. **MacLeod**. There are individuals associated with the organization which have developed small satellite systems.

Representative **Flippo**. Could you tell us, give us some insight on how remote sensing is utilized by AID? Could you give us some thoughts along those lines?

Dr. **MacLeod**. I'm not an expert in the area of the AID remote sensing activities, although I'm familiar with several instances of the programs. I'm much more familiar with the United Nations remote sensing applications.

Representative **Flippo**. Well, perhaps in that area.

Dr. **MacLeod**. But generally speaking, in the assistance programs directed to the developing countries, remote sensing is used as a primary means of supplying natural resource information, both for renewable, as well as nonrenewable resources. It constitutes, therefore, a vital source of information for the developing countries to revitalize, if not develop anew, their economies.

Most of the LDC's have been under the control of other countries; that is to say, they were colonies. They don't have a long-term backlog of resource information on which to draw.

By and large, these remote sensing programs constitute a very important, if not vital, element in their development programs.

Representative Flippo. Thank you. Thank you, Mr. Chairman.

Senator Schmitt. Thank you. Congressman McGrath?

Representative McGrath. Thank you, Mr. Chairman. Dr. MacLeod, could you enumerate for me how many other companies presently in operation could participate in perhaps this takeover, that would have responsibility for this program, say NOAA and NASA, organizations like yours?

Dr. MacLeod. Congressman, we're really not saying that we are prepared to take over the Landsat program. In fact, I think we're saying that we are not prepared to do that at all. We would like to see the program continuing as it is at the present time as an experimental program in which the Nation's R. & D. efforts will continue in that format.

Representative McGrath. Absent the R. & D. provision of service. You're in the business to do that.

Dr. MacLeod. That's correct. We are in the business of providing Earth observations data around the world in an open market.

Representative McGrath. Who else might be in business?

Dr. MacLeod. Pardon?

Representative McGrath. Who else might be in business at the present time?

Dr. MacLeod. Well, there are a number of large companies that have been very much interested in taking over both the operation of it, as well as other aspects of the Earth-observing and meteorological systems. I think we know that Comsat is very much interested in this kind of program, and I've heard of other similar interested organizations, large organizations.

Representative McGrath. Excuse me. Could you establish your particular company with the idea in mind down the road, if you rolled the dice, that the Federal Government was going to get out of the business?

Dr. MacLeod. No, Congressman. As a matter of fact, the company is formed as a result of recognizing that a particular form of Earth observations data would not be available in the future. That is to say, the current Landsat MSS type of data would begin to be phased out and a SPOT type, Landsat D, thematic mapping type of data would be made available.

We feel that there is a distinct and continuing market for the Landsat MSS kind of data. So the program is not predicated on taking over the Government program. As a matter of fact, we feel that if we are competing on a real cost basis, we can compete with the Landsat D and D' data.

So we're not looking for the extinction of the Landsat program.

Representative McGrath. Could you identify for us some of those markets for the services that you provide?

Dr. MacLeod. The largest market that we're looking at is the existing Landsat ground stations, those stations which are scattered around the world which can receive Landsat MSS at this time, or will be able to receive this in the near future. This is our principal market and we would be looking for station fees as our principal income.

We are also planning as another part of the business to sell processed data, value-added data.

Representative McGRATH. Do you believe that there is a sufficient market now to support privately owned land remote sensors?

Dr. MACLEOD. I do believe that. I do believe that those two market places can produce an adequate return on capital if the costs of the system are on the order that we've mentioned, $25 to $30 million. The reason for this is that that land remote sensing market for advanced high cost systems will begin to dry up and disappear as alternatives become just as cost effective as the Landsat, SPOT satellite data.

Also, we feel that our system will provide a great many more observational opportunities, a factor which has a substantial effect on the timeliness and continuity of data that Mr. Anderson of the National Association of State Legislatures mentioned this morning as a very desirable factor.

I do believe that there will be adequate return for capital if the systems are kept inexpensive. I don't think that experimental systems can be kept inexpensive.

Representative McGRATH. Where are we in relationship to the Japanese and the French? How is that going to affect the market availability?

Dr. MACLEOD. I don't know exactly what the Japanese are going to do. As far as the French system is concerned, in addition to their use of advanced American technology, they are providing a very high resolution type of data. The revisit times for acquisition of that data I don't believe will be as adequate as the system that we are proposing, but it will be an improvement over the current Landsat system, as well as the Landsat D.

There is a distinct problem with high resolution data being distributed about the world in an open market. My own experience is that in talking with people in developing countries, for example, we begin to shift from talking to resource managers to military people. And that introduces a distinct problem of acceptance of the high resolution data as a civilian product.

Representative McGRATH. In light of that response, do you believe that we're somewhat "double-parked" in order to get this particular transfer going?

Dr. MACLEOD. I think the high resolution systems suffer from that problem. I don't know that Landsat D or D' will suffer as much as the French system will suffer. It is a distinct consideration, though, particularly in the developing countries where there is a constant concern as to where that resource data is coming from.

Representative McGRATH. Thank you.

Senator SCHMITT. Thank you. Let me see if I understand. Could you just describe what you see the assets of your company being, the primary assets, the series of satellites.

Dr. MACLEOD. You mean when the system is completed?

Senator SCHMITT. Yes. The data in those satellites would be encrypted so that as you make a sale to a particular user, that data would go through their Landsat facility and you would provide, probably much on a model like direct broadcast satellites have been established, you would provide the decoding information to get through it, as long as they paid their bills, right?

Dr. MACLEOD. That's correct.

Senator SCHMITT. For the basic raw data, that's basically what you'd be providing; is that correct?

Dr. MACLEOD. That is our basic product; the raw data directly broadcast from the satellites.

Senator SCHMITT. You feel that each of those satellites could be designed using sort of Chinese copies of existing technology for about $25 or $30 million apiece.

Dr. MACLEOD. That's correct—not apiece. As a system.

Senator SCHMITT. For the total system?

Dr. MACLEOD. For the total system.

Senator SCHMITT. How many satellites?

Dr. MACLEOD. We're talking about four satellites at the present time.

Senator SCHMITT. So you're putting yourself in the position of NASA having created an experimental spacecraft that you think that can be stamped out and used more or less as it was created, for commercial purposes.

Dr. MACLEOD. I don't believe that it will look exactly like the NASA spacecraft.

Senator SCHMITT. I understand.

Dr. MACLEOD. But, yes, exactly. We feel that the time has come, that the technology is there, and it's a matter of assembling that technology in a launchable package at low cost to provide this kind of data, for which we feel there is a market.

We do not feel that there is a market for a high cost experimental system.

Senator SCHMITT. The main thing you hope that the Government will not do is develop a competing system supplying essentially the same information, subsidized, presumably, by the American taxpayers?

Dr. MACLEOD. I think the subsidization is the point. We are very much concerned about discounting the cost of the system and saying at the same time that this system, this technology has been transferred to the private sector. We don't feel that that is really an effective transfer.

Senator SCHMITT. So as you come on line, you'd like to see the Government stop providing the same kind of data, right?

Dr. MACLEOD. We'd like to have the Government charge what that data really costs. We don't feel that the Government program, as it stands right not, is necessarily a competitive operational system. For example, we will provide more opportunity for observations that the current Landsat D system will provide, as it's presently planned. And that's certainly true until 1985, before the thematic mapper begins to really produce adequate data for Agristars and other such systems.

So we would hope that even if Landsat D does go operational with its MSS, that we would be able to provide data at a cost that would be competitive and that we would even be selling data to the Government, although we're not projecting that in our market analysis.

Senator SCHMITT. What role would you see the EROS Data Center playing in this whole picture?

Dr. MACLEOD. I haven't really gone through that sufficiently to respond definitely to your question.

Senator SCHMITT. Will you think about that and provide it for the record because it's surely going to be a competitor supply center. On the other hand, you have advocated continuing the Landsat type of development which will be providing data that obviously should be available for use.

[The information follows:]

Response of **N. H. MacLeod** to the Question of Sen. Schmitt concerning private operation of the EROS Data Center.

The EROS Data Center has been established in Sioux Falls, SD, to serve several functions. The primary role of the Center, as the name implies, is the acquisition, archiving and distribution of earth resources remote sensing data. In addition the Center carries on a comprehensive training program, providing training resources to the government, to the states and universities and to remote sensing cadre from around the world, especially from the developing countries. Also, the Center provides up-to-date data analysis facilities on a limited basis, providing a limited R&D capability to advance the state of the image processing art.

These several functions, the marketing of remote sensing products, the development of image analysis procedures and the training of remote sensing specialists, have brought world-wide renown to the Center and its staff. It is thought of as the leading space remote sensing center globally.

The functions of the Center are a necessary part of the evolution of an operational land remote sensing system, as well as the continuing functioning of an operational system. The place of a Center such as EDC in the functioning of a commercial operational system is quite different than that in an experimental program. A commercial operational system requires, however, the same or a more efficient archival system, with special attention paid to the completeness of the data and to its quality. The continuous improvement of operational data processing systems also requires a certain amount of R&D as well as a continuous updating of equipment and software. In a commercial system, the user community requires a vigorous training program.

The EROS Data Center is an essential component of any global remote sensing system - commercial or public. The private sector interest is 1) the maintenance of the archival materials which form the basis of retrospective analysis and often the only available earth resources data source; 2) the training of users from the United States and abroad in introductory and highly advanced courses; and 3) in the advanced data handling methods that have evolved which now produce substantially higher quality data than the initial Landsat Data Products.

The continued availability of these resources is critical to the success of the ASTECH mission. Our program includes the establishment of data processing resources and data communication facilities, the training of users and the archiving of data. But our faciliities will be insufficient for system operation. We are therefore understandably interested in operations of the EDC as part of a commercial system.

Such a program would continue the training of US and foreign nationals in remote sensing technologies and applications with a staff very like that currently providing training. It would also maintain archives for production of retrospective products as well as current products using the recently updated production facilities. Services would be offered at payment levels to reflect program costs.

Should ASTECH operate the EDC, it would have the advantages pointed out in the description of the ASTECH Resource Management Information System (ARMIS) discussion (see submitted testimony). A single management for the total information system can serve as an optimizing factor in which system components are updated and shaped to meet the overall mission. In this instance, the objective is not to launch and fly space systems, or establish ground stations, or operate data production facilities such as EDC, but to manage natural resources with improved skill and efficiency.

We in ASTECH would be pleased to work with the Committees or with appropriate agencies to define an appropriate transition of the EDC from the public to the private sector.

Dr. MacLeod. The EROS Data Center and other such centers which are producing not really producing raw data; they're producing value-added data. I fee that the value-added industry is an existing industry and it's a highly competitive industry. That sector of the market that we wish to address—that is to say, the processed data that we would wish to sell—we would feel that we were competing with that market and that's fine. We would expect that. That's the existing situation.

So the EROS Data Center, if it operates at cost and at a modest profit—return to the Government, that is—we have no problem with that.

EROS Data Center, as Dr. Felsher has reminded me, also has a very important training component. We would feel that that training component should not be lost. It's a very important factor in the international projection of our technology.

Senator Schmitt. Why wouldn't you propose to take over that asset and operate it, both for yourself and as a service to the Government?

Dr. MacLeod. We have obviously thought about that and, in fact, we are developing alternative means because we feel that we can do it much cheaper than the EROS Data Center can do it. We don't have to go through an experimental mode as the EROS Data Center has. We don't have the training responsibilities that EROS Data Center has.

But I would prefer to really answer this question more definitively, if I could.

Senator Schmitt. Well, that and probably a few other assets that are part now of the ground system for Landsat is something that we will have to deal with in the legislation. Obviously, from your perspective, how we deal with them will definitely affect your competitive position in the market place.

Dr. MacLeod. We feel that we can sell to any existing Landsat ground station, whether it's Federal Government or owned by some other government or by some private industry. We feel if our data was of another nature—that is to say, at a higher resolution—that this, indeed, would change or position with regard to various ground stations.

Senator Schmitt. Mr. Lowery?

Representative Lowery. Dr. MacLeod, as I understand your testimony, you plan to put four satellites up for $25 million.

Dr. MacLeod. Yes, sir.

Representative Lowery. Is that low earth orbit or synchronous?

Dr. MacLeod. It would be a low earth orbit. It would be exactly the orbit that the present Landsat's are in.

Representative Lowery. How much would your launch costs be?

Dr. MacLeod. I'm sorry?

Representative Lowery. Your launch costs. What vehicle would you be using?

Dr. MacLeod. We are looking at a Scout vehicle for launching.

Representative Lowery. And the cost would be how much?

Dr. MacLeod. The costs on that vary according to the weight of the spacecraft. So I would rather not give you a precise figure on that.

Representative LOWERY. You're looking at one launch or all four?

Dr. MACLEOD. No; we're looking at possible dual launches. This is a very substantial difference in cost factors because we're talking $1 million to $5 million launches.

Representative LOWERY. $12 million; $500,000 per launch? What are you anticipating that the cost will be per launch?

Dr. MACLEOD. We're anticipating that the cost would be from $1 to $5 million per launch and that we would have a possibililty with the higher cost of launching two satellites at one time.

Representative LOWERY. $1 to $5 million per launch.

Dr. MACLEOD. Yes.

Representative LOWERY. That sounds a little low.

Senator SCHMITT. Scout's pretty cheap. Are they still making Scout's?

Dr. MACLEOD. That's a problem, The Air Force is considering shutting down the line.

Representative LOWERY. I wish you well and commend you. It sounds like your pencil is very sharp.

Thank you, Mr. Chairman.

Senator SCHMITT. Well, the interesting thing is if he's off by a factor of two, he's still better off than where we are today.

Mr. Chairman?

Representative FLIPPO. No questions?

Senator SCHMITT. Any other questions? We'll have some additional questions for the record while we digest what you're saying. I think one of the key elements is to make sure that when we open up a sector, that cartain key elements of remote sensing activity won't fall through the crack. You're looking at a fairly specialized market utilization that you would try to serve. The question is, Once you've established that, woud you then want to expand? Would others come in? Would you want any protection from competitors other than the Government, or what?

Those are issues that I think we have to resolve and your thoughts on those will be very helpful to us. There are more and more interesting proposals developing now that I think a lot of people have sensed that the Congress and the administration might actually be willing to spin this off.

Representative MCGRATH. Mr. Chairman?

Senator SCHMITT. Yes, Congressman McGrath?

Representative MCGRATH. Have you factored in your costs the cost of insuring the launches and insuring your service?

Dr. MACLEOD. Insuring the services—we have not factored that in. Insuring the launches, we are considering that. We have not had any substantive bids for that.

Representative MCGRATH. What kind of an estimate are you making? If I told you a ball park figure of 10 percent for the launch cost, would that be out of the ballpark?

Dr. MACLEOD. I think that would be perhaps conservative, as a matter of fact.

Representative MCGRATH. Thank you.

Senator SCHMITT. Have you made any estimates of when the system would be operational?

Dr. MacLeod. Our design objective is to have a flight-worthy instrument within 18 months after contract. So we're looking at a 2-year program for a launch program.

Senator Schmitt. OK. Well, thank you, gentlemen. We'll convene tomorrow at 9:30 a.m., in room 2218 of the Rayburn Building on the House side. We get to do the walking tomorrow.

We have a statement from Senator Riegle and questions to be submitted for the record. If there are any other statements, they'll be inserted in the record at this point.

[The prepared statement, plus answers to questions asked of Senator Riegle follow:]

Statement of Hon. Donald W. Riegle, U.S. Senator from Michigan

In 1972, with the launch of Landsat I, NASA began a remote sensing program which gave us the capability for collecting information needed to solve global national resource problems. Landsat can help us predict crop yields, manage forest resources, improve our maps, plan our cities and much more.

The smooth and continuous flow of Landsat data are a tremendous resource which can save time and money for State and local governments, public utilities, farmers, foresters and innumerable others. In short, Remote Sensing Technology is a resource with great potential and I would encourage continued efforts to develop, apply, and transfer this technology to all that might benefit from its use.

In my own State of Michigan, we are very proud of the efforts we have put forward to utilize Landsat data.

The Environmental Research Institute of Michigan (ERIM) is internationally known and respected for its efforts in development, application dissemination and consultation of Landsat technology.

Two of our major universities, University of Michigan and Michigan State University are involved with remote sensing in a major way. Both institutions interact with State and local governments to demonstrate the practical benefits from the use of remote sensing technology. The NASA University applications program for the State of Michigan is headquartered at Michigan State University.

Each year new uses for Landsat data are developed.

Michigan's Department of Natural Resources used Landsat data to classify the water quality of lakes; the Region V Planning Commission in Flint, Michigan, utilized Landsat data in combination with aerial photographs to put together an accurate environmental record of current land use and regional water quality. This project was undertaken to satisfy a Federal requirement. Finally, the Geospectra Corporation is a private corporation in Michigan which has used Landsat in the search for oil, gas, and minerals.

These are just a few examples of the practical applications of remote sensing data. I am sure State Representative Anderson knows of these and many others. Landsat is an effort we can all be proud of. Once again our country has been on the cutting edge of new technology.

Landsat has been a good investment and we want to protect it by making the right decisions about its future. These hearings will I hope be useful in answering some tough questions about the future of remote sensing technology. For example:

How can the United States maintain its lead in this technology? How rapidly and in what way should Landsat technology be moved into the private sector? What is the best way for us to be certain that we maintain a continuous flow of Landsat data?

I think these are vital questions, and I welcome today's hearings and look forward to a bright future for the use of remote sensing technology.

QUESTIONS OF SENATOR DONALD W. RIEGLE, JR.

1. *In your testimony you indicate some serious concerns about the private sector taking over Landsat. Under what circumstances do you feel that the transfer of Landsat technology to the private sector would be beneficial?*

I am not opposed to a transfer of the Landsat System per se. I could support such a transfer if the private sector operator was able to deliver continuous, reliable data on a timely basis at a reasonable cost. I would define timely as delivery of data within two weeks of receiving an order. Reasonable prices would include phased increases announced well in advance with no more than a five times increase by the end of the decade.

2. *I note that technology transfer is the number one priority of the states. Can you give us some idea of the benefits derived from the Technology Transfer Program and the problems that would arise if it were suddenly terminated?*

The states have derived a great deal of benefit from the NASA Landsat Technology Transfer Program. It has given many states a low risk, low cost opportunity to evaluate a valuable new technology on an application and in an area of their own choosing. These demonstration projects of the Regional Applications Program have been cooperative efforts, with the states providing staff time for investigating applications and evaluating the data, travel funds for technical assistance at NASA centers, and field crews to gather ground truth data. NASA provides data computers to analyze on it and their technical expertise. Most states which completed these projects have implemented in-state processing and applications capabilities. NASA researchers also benefited from the opportunity to interact with operational users on a real-world basis.

The low risk, low cost aspect has been crucial. With state budgets tight, and getting tighter all the time, it is in the public interest to facilitate the exposure of state resource managers to this significant new tool. The aspect of users choosing applications and areas is also important. When it comes to newfangled gadgets, we're all from Missouri and want to see what it can do in our own back yard. Any legislator who looks at a Landsat photo of his district can understand this.

The greatest benefit of the NASA Landsat Technology Transfer Program has been the promotion of Landsat usage by decision makers, planners and resource mangers in our state and local governments. If the program were to be terminated suddenly, before all the states were at least offered the chance to complete a demonstration project, public sector usage would not grow at nearly as fast a rate as it might have.

3. *What sort of changes would we need to make in the Landsat program to make you feel confident about the continued availability of data?*

The only major change needed in the Landsat program to instill user confidence in the continued availability of data is the construction of a third Landsat-D to assure data continuity.

4. If Landsat were transferred to the private sector what suggestions would you make to ensure the continued availability of affordable data for state and local governments and other public purpose?

The best way to ensure the continued availability of affordable data for state and local governments, as well as all other users, is to formalize the committment to continued federal support of an operational system, regardless of whether it is a publicly or privately run system. Phased price increases, announced well in advance so as to allow the increases to be adjusted for in state and local budgetmaking processes, and limited to no more than a five times increase by the end of the decade will result in a steady growth of usage and a self supporting system sooner than precipitous increases which would discourage growth of the user base across which costs are spread.

Should it prove impossible to limit price increases in such a fashion, I would like to suggest that the public policy importance of state and local government Landsat usage is such that consideration should be given to either direct subsidies to nonfederal public sector users or to a two-tiered pricing structure for public vs. private and foreign users. Either of these solutions would recognize the value of Landsat data for public purposes and, if a private sector system is selected, allow the operator to partially repay the $1 billion federal investment in Landsat.

[Whereupon, at 12:30 p.m., the hearing was adjourned, to reconvene at 9:30 a.m., Thursday, July 23, 1981.]

CIVIL LAND REMOTE SENSING SYSTEMS

THURSDAY, JULY 23, 1981

House of Representatives, Committee on Science and Technology, Subcommittee on Space Science and Applications; U.S. Senate, Committee on Commerce, Science, and Transportation, Subcommittee on Science, Technology, and Space,

Washington, D.C.

The subcommittees met at 9:33 a.m., in room 2218, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the House subcommittee) presiding.

Present: Senator Schmitt; Representatives Flippo, Fuqua, Hollenbeck, McGrath, and Nelson.

Mr. Flippo. The hearing will come to order.

Today, we continue our joint hearings on civil land remote sensing. We had a very interesting session yesterday on the Senate side where we heard from NASA and NOAA, representatives of the States, and one representative of the private sector who proposed to build a privately owned and operated satellite system to provide Landsat-type data.

Today, we will hear from public witnesses representing the universities and industry.

One thing we did not address in depth yesterday was the international value to the United States of the ability to deliver Landsat data to foreign nations. Our first witness, Dr. David Simonett, will be able to address this subject area. He will be joined in a panel by Dr. Kenneth B. Craib, an economist who has worked in this area both as an academic economist and through a commercial firm.

Of course, if we are talking about transferring to the private sector, we need to understand their views. Our second panel of witnesses will include Michael T. Halbouty, independent geologist, Dr. Joseph Charyk of Comsat General, and Allen Rosenberg of General Electric. These three gentlemen bring a great deal of experience to the table with them.

Mr. Halbouty has made major contributions in petroleum exploration and continues by working with the Geosat Committee to apply remote sensing techniques in geology. Of course, Comsat has a great deal of experience in space operations, and we believe he will have some interesting concepts to discuss with us today.

General Electric is involved in developing the Landsat-D system, especially the ground system.

So we have a fine group of witnesses who should be able to help us deal with this issue. I welcome you all and would like to see if the distinguished Senator from New Mexico, Mr. Jack Schmitt, has an opening statement.

OPENING STATEMENT BY SENATOR SCHMITT

Senator SCHMITT. Thank you Mr. Chairman. It is great to be with all of you here today. This is, I think, the ideal way to conduct a set of hearings and keep us all on track.

As members of the committee are aware, yesterday we began our discussions of the organization and management options available for development of an operational Earth resources information system. I hope that this continuation of those hearings provides an impetus for both the private and public sectors to move ahead.

The potential benefits, Mr. Chairman, of this type of technology to the country and the possibility that we may miss this opportunity must be taken seriously at this point in our history. We are now just one tape recorder away from having little or nothing at all as an Earth resources satellite system while the French and Japanese are stealing our technological thunder in more ways than one.

It makes me wonder how many in the Congress are going to be willing to appropriate money in the Federal budget for data derived from the SPOT system just because our Government and industry procrastinated for so long.

The issues that need to be resolved are not easy ones to answer, but not answering them does not make them go away. In fact, the issues raised in the 1977 GAO report on Landsat's role in an Earth resources information system are just as current today as they were 4 years ago, which means we have lost another 4 years.

The cure for this paralysis does exist, and I believe that these 2 days of hearings are setting the stage for near-term constructive action. I was encouraged yesterday to see that there seemed to be a general overall consensus that that action did involve a very direct and clear participation in the competitive private sector.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you, Senator.

Does the gentleman from New York have an opening statement?

Mr. MCGRATH. No, sir; let's get going.

Mr. FLIPPO. Would our first two witnesses, Dr. David Simonett and Mr. Kenneth Craib, please come to the witness table?

Gentlemen, feel free to offer your statements in total for the record. We look forward to some interesting discussions. And I might suggest that to insure fairness, we are going to take 5-minute turns in the questioning and go around as long as time permits.

My saying this is to urge you to be as concise in your statements as possible so that we will have maximum amount of time for questions.

It is a pleasure to have you here. And please begin as you deem appropriate.

If there are no objections, we will permit photographs during the testimony.

Is that satisfactory with you, Senator?

Senator SCHMITT. That's all right as long as I'm in them.

Mr. FLIPPO. It is all duly noted.

Please begin.

STATEMENT OF DR. DAVID S. SIMONETT, DEAN OF THE GRADUATE SCHOOL, UNIVERSITY OF CALIFORNIA

Dr. SIMONETT. Mr. Chairman, Mr. Schmitt, thank you for the opportunity to testify. My statement has been tendered, and I will not read from it. I wish to make a few terse points in order to, in effect, open a dialog.

The first is that this is a revolutionary technology. And a revolution sometimes takes place over a long period of time. And I think we must be cognizant that the revolution needs to penetrate to the lowest sector of what we can refer to as a pyramid of users.

The second point I would like to make is that pricing and timing issues are crucial with respect to this pyramid of users. And a single price cutting across the pyramid could differentially segregate out a large share of users among whom would be universities, particularly the smaller ones, and among whom would also be a large group of the less developed countries.

In the international area, it is important to recognize that, in effect, we have been engaging in a transfer payment to the LDC's by the low pricing that we have used and that it needs to be acknowledged that that has value in itself.

The next point that I would like very briefly to make is a concern with respect to commercialization and the role of science and research. In this respect, it is important that the private sector as they enter into new arrangements acknowledge the special role in the United States of joint research between the private sector, the Federal Government, and the universities, and some kind of levy mainly to be exercised in order to keep the flow of research going into training young people. It is the cheapest form of research in the United States.

The final point is that a considerable share of the training of foreign nationals takes place in the United States, and we must bear in mind the differential effects of a reduced flow of young people from the foreign LDC's if we, in effect, cut out a share of interest in that area by our pricing schedules.

That, then, finishes my comments.

Mr. FLIPPO. Thank you very much.

[The complete prepared statement, plus answers to questions asked of Dr. Simonett follow:]

ALTERNATIVE PASTS, PRESENTS, AND FUTURES IN SPACE REMOTE SENSING

David S. Simonett
Professor of Geography
Dean, Graduate Division
University of California
Santa Barbara, California 93106

Our present view of the commercialization of remote sensing is conditioned, even artefacted, by the chance stream of events over the last twenty years and by new developments in parallel technologies. The purpose of this brief presentation is to provide some terse historical context on these past and present alternatives, plus some speculation on the future applications of remote sensing which may have some bearing on private sector roles in space remote sensing.

My comments are given in the form of a series of questions and "answers."

QUESTION: By implication you assert that our present view of space futures is essentially one-eyed. Why do you think this is so?

ANSWER: 1. Our assessment of space futures is based almost entirely on the Landsat multispectral scanner, the first experimental system. Consider the following possible pasts and the idiosyncrasity of reliance on our MSS-dominated experience is apparent.

Past A.

The MSS loses the battle for inclusion on ERTS A. (In fact, it nearly was excluded as an instrument on ERTS. It owes much to the persistence of Dr. A.B. Park, then of NASA, that it survived strong counter-voices in NASA and the U.S. Department of the Interior. The latter felt that the Return Beam Vidicon would be much the more useful instrument, and that MSS would be only of marginal value. So much for forecasting in a situation of uncertainty.)

Past B.

The MSS is accompanied on ERTS A not by an RBV but by a high resolution X-band radar, which penetrates cloud cover. As a result the pattern of usage of each instrument is strongly influenced by the degree of cloud cover in diffent environments and countries.

Past C.

The first MSS and those on subsequent ERTS (LANDSAT) satellites, failed after a short period in orbit,for minor technical reasons. As a result the U.S. Department of Agriculture (SRS) experiments in using LANDSAT to improve crop forecasting were short circuited as were the LACIE and other programs developed by mineral, petroleum, and forest products companies.

Past D.

A very high resolution scanner accompanies the MSS. As a result a variety of new procedures are developed for employing MSS data in conjunction with high resolution data.

2. Our present assessment of space futures is strongly conditioned by the growth of microtechnology. This growth occurred since the first launch of LANDSAT, mostly in the last five years.

3. The National Science Foundation rather than leaving most remote sensing research to NASA (and to a lesser extent USDA and NOAA), heavily funded basic and applied remote sensing research in universities. (After the launch of ERTS-1, there was a sharp downturn in basic remote sensing research in NASA.) As a result there is a wider base of physical modeling approaches employing LANDSAT MSS data than that presently available.

4. A consortium of mineral, petroleum, forest products and agricultural products companies responds to a NASA

initiative and establishes an aggressive joint venture research and development program in concert with NASA, in lieu of LACIE and related research and development programs.

5. At the launch of ERTS-I, the Office of Management and budget accepted the view that - in order to stimulate a wide base of users of the new technology - NASA and the Department of Interior should provide resampled computer compatible tapes in a format suitable for full overlay in geographic information systems of standard U.S. Geological Survey 7 1/2 minute quadrangles. This front-end subsidy was designed to stimulate users in state and local governments.

That none of these possible pasts has occurred over the last decade is beside the point. What is important is that our present assessments are based on only a small fraction of the alternative technical, reliability, political, and financial possibilities.

QUESTION: What have we learned in the last nine years from our research, development, education, and applications programs using an acknowledged limited sensor - the MSS?

ANSWER: In answering this question, it is possible only to give a series of assertions based on judgment, with all the frailties with that implies:

1. The digital format of the multispectral scanner, coupled with the lowered cost of minicomputers and microcomputers, has established that the digital route will be followed in almost all future research and operational applications. It is difficult to think back eight years to the debate whether digital procedures would substitute for bulk-processed image products. As recently as five years ago, this was still a matter of contention and debate, and in the geological community in particular, there were many who were convinced that remote sensing from space had essentially

minor applications to geological exploration. By 1978, however, the GEOSAT committee, with substantial representation from the mining and petroleum exploration companies, had come into existence. An aggressive posture was being adopted by these companies on future space remote sensing systems.

2. Special processing of LANDSAT computer compatible tapes has become widespread. Digitally enhanced images of various types are being purchased, inter alia, by petroleum and mining companies, foreign governments, the World Bank, the U.S. Agency for International Development, and forest product companies.
3. Mathematical and statistical modeling of natural and cultural systems were being extensively researched, developed, and in some instances were already in operational use. The following examples give some flavor of these developments:
   - i. The USDA/SRS uses LANDSAT data in conjunction with ground sample statistics to improve their forecasts of crop acreage.
   - ii. Forest products corporations use LANDSAT as a component in their geographic information systems for forest management.
   - iii. Physiological modeling of crops using NOAA meteorological satellite data was being researched in NASA and was in operational use in at least one private corporation. This is in fact competitive with LANDSAT.
   - iv. Integrated systems-type approaches employing multiple satellite data sources (meteorological satellite data and LANDSAT data), multiple sources of digital geo-referenced data (soil information, digital terrain models, etc.), and mathematical and statistical modeling of environmental parameters (atmosphere, vegetation, snow, water, etc.) were under development.

v. Mini and micro computers have so reduced basic computation costs that small universities and state and county agencies will soon be able to incorporate some digital processing into their present procedures, thereby greatly increasing the present market for digital computer compatible tapes.

QUESTION: What market is presently available, or could be available, for private sector take-over?

ANSWER: It is still rather early for commercialization of space remote sensing. The scientific and practical potential of remote sensing is so high that I am bullish on the technology in the long run. However, among the certain ways of turning off the technology, or severely retarding it, will be to follow OMB and adopt a full or near-full cost recovery for the ground-segment of the costs. We could even go further and attempt to recover some of the recurring operational, or development costs! In my view it would be better to continue the subsidy to broaden the domestic and international base of users (the latter could be treated principally as a direct subsidy to the developing world). The reasons for my positions are as follows:

1. There is at present no clearly identifiable market. It is diffuse, multi-user, particular, specialized, distributed over many industries, and still under development. We must persist with our subsidies for a while longer until the newly educated generation of computer-compatible scientists is well distributed throughout the universities, private sector, and federal, state, and county agencies.
2. Full cost recovery will be an unreleived disaster. Indeed, there are those in the education community, myself included, who believe that the Federal Government must take a long-term view to educating a generation of potential users.

3. The Department of Interior recovers about one third of the actual costs of running the EROS Data Center in Sioux Falls, South Dakota; NASA in providing its MSS scene masters appears to violate general U.S. Government stated policy, as described in the "User Charge Statute" of 1976 and OMB's circular A-25. Sheffield (1978) points out that "were these policies being followed, it is estimated that NASA should be charging at least $300 per MSS scene master delivered to the EROS Data Center." Without the present subsidy even the present market would not exist. If OMB has its way and pricing is made much more in line with the "real" costs, this will be the most certain way of turning off further development, both domestically and internationally. The price of geologic, topographic, and land use maps issued by the U.S. Geological Survey is that of the printing costs alone. In an information-based society, the Federal Government has clearly, for some areas, adopted a policy of absorbing the front-end costs, thereby enabling a very wide base of users to develop and distribute the benefits to a much wider segment of society than would be the case with a higher cost recovery. It is my view that such a policy must continue, possibly for at least another decade.

QUESTION: What does the future hold, for the growth of the technology and for the move to the private sector,

ANSWER: The future is as uncertain as the alternative pasts mentioned earlier. On the one hand we could adopt a series of policies which will have a severe negative ratchet effect on the growth and adoption of technology, and on the other hand we could adopt policies which would have a strongly stimulating effect on its growth and adoption. The role of the private sector, and its readiness to enter very substantially into various segments of space remote sensing will be strongly conditioned by these postures.

1. A low side outcome with limited participation by the private sector will be likely if some combination of the following disincentives occurs:

i. Substantially increased or full cost recovery of ground segment costs is required by OMB of a private contractor.

ii. Uncertainty with respect to the Federal Government's intentions on partial or full recovery of ground costs continues for several years.

iii. Partial or full recovery of the operational costs of the space sector of the remote sensing program is required by OMB.

iv. O.M.B. attempts to recover a portion of the development cost of satellites, rather than treating it as a sunk-cost.

v. Reduction in the funds available for basic research in remote sensing through NASA, the National Science Foundation, and other federal agencies.

vi. Launch failures of LANDSAT D vehicles, or poor performance of the sensing devices.

vii. Severe limitations on remote sensing equipment placed on board space Shuttle.

viii. Severe slowdown in the development of further instrumentation for new generation space sensors by NASA.

2. A high side outcome is likely to be stimulated by some combination of the following circumstances:

i. A clear commitment by the Federal Government to continue its policy of limited cost recovery for the ground based segment of space vehicles, at least for the next decade and treatment of space-segment development and operational costs as essentially sunk.

ii. Aggressive increases in basic and applied research, funded through the defense agencies, NASA, other civilian sector agencies, and the National Science Foundation.

iii. Provision, at less than full cost, of specialized products of high leverage in resource management, such as geo-referenced and reformatted data, re-sampled to provide permanent pixel locations on U.S. Geological Survey 7 1/2 minute quadrangles, or comparable bases.

iv. Roaring successes with the French SPOT Satellite and future Japanese satellites.

v. Wide acquisition of high resolution photography from space, employing space Shuttle.

vi. Further explosive growth in mini-computer and micro-computer technology.

vii. Development of joint-ventures for new satellite instruments via consortia of private corporations (such as the GEOSAT group) and the Federal Government.

viii. Pursuit of joint NASA/private sector/university/ cooperative research, development and applications.

ix. Adequate insurance against loss of space-segment hardware.

x. Rapid development of high resolution synchronous remote sensing satellites, space radars, and third generation optical sensors.

xi. Deliberate stimulus of the stream of university-educated persons now being developed. In this respect remote sensing is unlike the micro-electronics business where most development and training is within industry and universities sadly lag. The National Science Foundation took an early lead in sponsoring remote sensing education, for some five years and then dropped it. Remote sensing could benefit from further stimulus in this area.

In summary, it is important not to draw facile and misleading analogies with the communications satellite business. Remote sensing requires a longer lead time before moving into the hands of the private sector than was true for communications satellites. The communications business was already in place when satellite communication became an alternative; remote sensing in any significant sense really began with the launch of ERTS-1. More education, more research, more experience, and a rather long period of deliberate subsidy is needed.

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

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October 8, 1981

To: Congressman Ronnie G. Flippo
Chairman, House Subcommittee on
Space Sciences and Applications
Suite 2321, Rayburn House Office Building
Washington, D.C. 20515

Attention: Mr. Tom Potts

From: David S. Simonett
Dean, Graduate Division
University of California
Santa Barbara, Ca. 93106

Re: Response to House Subcommittee on Space Science and Applications
Committee on Science and Technology

Questions for Land Remote Sensing Report.

Question 1. The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.

(a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

Response: These questions have not been asked generally of the scientific community, or ever addressed adequately within NASA. The answers will change and mature with our understanding of the problem. A study underway by Frederic Billingsly of Jet Propulsion Laboratory attempts to combine uses on a single satellite through the following procedure: 1) Find the altitude at which a series of coverages can be met. These will include, 2) frequent (9-day) coverage with relatively coarse resolution multispectral remote sensing for agricultural and hydrological purposes, 3) three-monthly, intermediate-resolution multispectral sensing for seasonal natural resource sensing (forestry and some rangeland applications), and, 4) six-monthly to annual sensing with very high resolution single-channel imaging (needed to meet some geologic applications). Very little of this type of analysis (which is required to address Congressman Flippo's question) has been done. Another recent example is a study by General Electric Corporation looking at future earth-synchronous satellites which could be used for resouce sensing. Such satellites could clearly be combined with earth-synchronous meteorological satellites. Recent studies of radar satellites suggest that most short and long term resource needs covering agriculture, hydrology, and geology, might reasonably be met by observations from satellites in tandem, in parallel orbits. Since our ability to postulate future systems and satellite altitude, orbit and time repeat-time characteristics are only now being explored, it is likely that some very interesting and worthwhile combinations may be achieved. I believe the answer is generally favorable to combinations of instruments on a single satellite to address multiple needs.

Question 2. Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of the LANDSAT system and whether the system should be operational now.

Question (a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

Response: LANDSAT was not designed to be optimal for any natural resource use. When launched it was in every way a design compromise between competing uses and agencies, notably agriculture and geology and the USDA and USGS. Nevertheless, its quasi-continuity and familiarity have bred uses which were not obvious at first sight. Many states, for example, now argue that the present LANDSAT system should be continued even as newer and better systems are placed into commission.

Sub-optimization is a natural ingredient of almost all space systems. The multispectral scanner (MSS)-LANDSAT combination is acceptably sub-optimal for many uses. This has led to the pressure to retain the multispectral scanner on LANDSAT D, by many state and other agencies in the U.S. That's the clearest indication which can be given that the present system is useful.

Question 2 (b) What is the applicability of LANDSAT D to an operational system?

Response: A two-satellite LANDSAT-D system, containing both the multispectral scanner and the thematic mapper, would be particularly useful for agricultural sensing and could bring improvement to virtually all other applications sectors. However, the higher resolution and the additional channels of the thematic mapper would produce a sharp increase in data rate from 15 to 110 million bits per second. This would impose significant additional requirements on the ground-based data reception and data processing sub-systems and on the processing employed by all applications users. The multispectral scanner carried with the thematic mapper would serve the needs of receiving station and users not yet prepared to shift to the more advanced technology and would retain comparability with earlier LANDSAT data and could serve as a backup to the untested thematic mapper. For all of these reasons LANDSAT-D is very applicable to a potential operating system if the multispectral scanner is included on LANDSAT-D. At the same time having the thematic mapper and the multispectral scanner carried together on the same spacecraft would facilitate bridging to the more sophisticated system.

Question 2 (c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80s with the present approved program?

Response: I do not think we have adequate backup to maintain continuity of service. The combination of a commitment to an operational system, the maintenance of the necessary supply of spare instruments and satellites, and the freezing of the technology on a rather simple 4-channel system, all appear necessary in order to give a high degree of assurance for continuity at this stage. None of these elements is yet in place. With great good fortune and no launch instrument failures we would still fall short of adequate coverage in time and space through the 1980's. LANDSAT is now of marginal use. LANDSAT-D has yet to be launched!

Question 3 Policy issues relating to the proper government/private sector relationships and the scope of the involvement of the commercial sector are in need of further clarification.

(a) By what process should responsibility for remote sensing move to the private sector?

Response: For a whole complex of reasons the move to the private sector will have to be staged. If individual corporations or consortia of corporations bid for the rights to provide satellite data they will need guarantees of adequate time to generate a significant return on their investment, for insurance against hardware losses, of continuation of government R & D which could lead to further advanced systems for the private sector, of government business in the early years at least to provide a stable base for operations, of government subsidy or price support mechanisms for users at the base of the pyramid of users, of negotiation on rights to a federal share of profits and related matters. For all of these and other difficult issues I see no substitute for the development of a long-term contract between the government and a private sector company or consortium, subject to annual review in the early stages as operating and cost experience firms up, and then phasing into a biennial review.

Question 3(b) Do you believe that the private sector could successfully opererate both the space and ground segments of an operational system (leaving aside the question of finances)?

Response: I have no doubt at all that the private sector could successfully operate both space and ground segments of an operational system, and eventually do so at less cost than the government. I would be hesitant about a full monopoly and would prefer as many sections of the entire system to be broken out for separate bidding by different companies, but with a prime having overall responsibility.

Question 3(c) Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so what would they be?

Response: I would be very reluctant to see a full monopoly controlling all phases of an operational system. However, as noted in the response by the Chairman of COMSAT to questions about the COMSAT proposal, sizeable pieces of the system could be separately bid upon by U.S. and foreign corporations. There are many attractive aspects to the COMSAT proposal (at least they are prepared to be risk-takers!) A monopoly always would have the risk of becoming complacent. However, the U.S. will have no monopoly of space. Foreign joint-venture corporations (government and private companies) will undoubtedly enter the market-place in increasing numbers. The

French venture with SPOT, the European ventures now gathering steam in space imaging radar systems, and Japanese ventures are a clear indication that no real monopoly can exist. For this reason there could be a real advantage to a prime U.S. contractor with quasi domestic monopoly, coupled with open competition for as many sub-systems and sections of the operation as feasible.

Question 3(d) How much guaranteed government business of assistance would be required to enable the private sector to assume major responsibilities for an operational system. Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

Response: Some guarantees or assistance will certainly be necessary. If national and international markets develop as anticipated during the next decade the government guarantees and/or assistance should correspondingly diminish during that time. The COMSAT experience with marine navigation satellites is very instructive in this regard. The early government guarantees and guaranteed level of business enabled the commercial market to be established and eventually to reduce the costs for all parties, including the Navy. There is every reason to believe a comparable situation will emerge with some, if not all, civil land remote sensing satellite systems, particularly if consolidation with meteorological satellite systems is developed. I doubt whether government subsidies to existing systems have the effect of diminishing competition and inhibiting innovation. The competition between nations will be substantial, and subsidies or guarantees should be strictly limited in time.

Question 3(e) Is a copyright provision necessary for private sector operations?

Response: Some copyright mechanism appears essential. However, if prices of digital tapes increase significantly some pirating will be inevitable. Since the market-place is very diffuse and scattered it is doubtful that pirating could be at a level sufficient to seriously undercut the prime contractor. My own view is that copyrighting is essential, that pirating of original digital tapes is likely to be modest, and that we should wait to see the magnitude of the pirating problem before becoming frantic over it. Secondary and specialized processes should have the same rights to proprietary processes that they now have. A number of companies in the U.S. have developed specialized copyright processing techniques for use with LANDSAT data and marketing their products vigorously.

Question 3(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

Response: I have no doubt that non-discriminatory data access is compatible with private sector involvement. It essentially is the case now with the commercial communication satellies and I see no reason to believe the same can't apply with civil land remote sensing systems. Indeed, if discrimination were to begin to be employed the whole structure of international cooperation and acceptance of remote sensing would erode. I regard non-discriminatory access as essentially non-negotiable, and to be related to the freedom of space concept that the United States government has supported through the years.

Question 3(g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e. to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

Response: I do not believe that any U.S. corporation should be allowed to have proprietary rights to data. This would so undermine the integrity of the U.S. government's position on the freedom of access to space, that it would amount to an over-turning of policy. If individual companies, or consortia of companies made up of major U.S. oil exploration and mining enterprises were to participate, for example, in such a venture, it would seriously polarize developing world nations. Their deep suspicions of the U.S. role in space, which were severe some five years ago, but have been allayed recently, would re-emerge, much intensified. I believe such independent-corporation remote sensing systems may be entitled to a brief period of restricted access, for their own internal research purposes, but even this should be approached with great caution. My own disposition is to argue that all systems should be totally available for purchase to all parties, worldwide, who can meet a reasonable purchase price. Freedom of space surely means nothing less than this. If the spatial resolution of some future systems becomes sufficently good that serious questions of invasion of national and personal privacy become significant, this would suggest that there is a limit to the resolution that should be employed with complete freedom of access. My suspicion is that the tolerance of the international community for improved spatial resolution will increase with time, and will settle out at a level that will be acceptable technically. Wait and see.

Questions 3(h) through 3(l) are more appropriate for other persons than myself to attempt a response.

Question 4. Universities are currently involved in research and training in the area of remote sensing.

(a) How is the contribution of the universities important?

Response: The university role in the growth of a new technology such as remote sensing is multi-faceted. At the one extreme there are the large research universities which grant the Ph.D. degree, and in which both basic and applied research on remote sensing technology and applications are carried out. At the other extreme are the small institutions in which a few undergraduate courses employing remote sensing may be given. The latter, which are large in number, serve a broad educative function in allowing a large number of university graduates to at least be aware of the existence of the technology. This is an important part of the general educative process in a high technology society. The former serve a special role in providing the creative and highly skilled technologists, who have grown up with intense and focused disciplinary and inter-disciplinary work in remote sensing within a vigorous research program. These people in many ways are the continuing agents of change. As they graduate and move into private sector and government employment the continuing feedback between the education, funding, and business/applications communities develops. Much of the last eight years, since the launch of LANDSAT 1, has been spent in bringing together the elements of this process. Well-trained graduates of the universities are now reaching middle-level positions within government and are encountering other colleagues who have at least heard of the notion of remote sensing. A complex technology such as remote sensing is going to take tens of years to fully permeate and be maximally effective in both government and private sector resource monitoring and assessment. The research and training programs at the Master's and Ph.D. degree level of major universities are absolutely key in this process. As is true of most high technology areas the graduates of such degrees do not have to hunt hard for jobs. Companies are interviewing on campuses for such graduates.

Question 4(b) What should be the role of universities in the future, that is if we have an operational system? What should be the role of the Federal government vis a vis universities?

Response: The role of the university in the future in relation to an operational system could very well be analogous to that with the operational meteorological satellites. Research is being carried out with data derived from operational meteorological satellites. Such research is an integral part of gradually improving the range and efficacy of uses of the operational satellites. The universities are qualified to do such research, and carry it out at less cost than any other sector of the research community, and hence it is a proper investment of federal research monies in universities to have the training and research elements carried out hand in hand. An even larger element of university research would naturally be concerned with the newer instruments and devices under the process of development, and launched for experimental testing. It is always a question of balance. Some systems, even when operational, mau generate a large number of useful research ideas. Universities will be sufficiently entrepreneurial to find these and to convince funding agencies that they are of sufficient merit to be funded! No specific federal government intervention or subsidy would be required for universities to do what comes naturally to them. However, there is a concern that remote sensing research and development thinin the universities not be allowed to wither with reduced federal funding. The pattern of research and development in microtechnology in the U.S. provides a warning in regard to remote sensing: the universities lag seriously in both R & D and education in microtechnology; the action is overwhelmingly in the private sector, with all kinds of serious consequences for research and education. It is important that basic remote sensing research as well as applied research continue to be federally funded, and that the National Science Foundation enter more vigorously into both areas. Cooperative government/industry/university research will be beneficial in helping to maintain the U.S. lead in R & D in remote sensing. The Japanese and West Europeans have moved very rapidly in the last two or three years. Cooperative university research under both federal and private funding will ensure that universities will remain at the leading edge in both research and teaching. Research and development must continue into the indefinite future under both federal and private sponsorship. Both components are essential for healthy growth in basic applied engineering, applications and development areas, as well as in basic research.

Question 4(c) How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

Response: Commercialization per se is neither especially beneficial or disadvantageous to universities. I see it as essentially neutral. However, some of the consequences that could flow from decisions associated with, but not necessarily a necessary ingredient of, commercialization could have a severe impact on the universities. I refer specifically to the question of pricing policy. I am strongly prejudiced in favor of a continued federal subsidy for a further period of at least five, and preferably ten, years of provision of low-cost data to universities. A rapid increase in costs of the raw data will reduce the amount of research being done if the total research dollars remain constant. From about 5 to 8% of total present research costs, the raw data costs may move to approximately 30% if some of the pricing schedules under consideration in NOAA are employed. With a relatively modest research budget available for remote sensing in the universities this is a serious matter. There are various ways in which such a subsidy could be handled. A separate fund could be set up that would enable federally funded research projects at universities to obtain a direct subsidy from the fund, and still pay general commercial rates. A variety of other mechanisms are available.

Question 5 Satellite data is being utilized to provide data for public services.

(a) How is the utilization of remote sensing data important to the public welfare and health?

(b) To what extent are state and local governments utilizing this data for public services?

(c) What are the primary concerns of the state governments (i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3? (ii) with the future commercialization of land remote sensing?

Response: This question is more appropriately answered by persons from the state governments.

Question 6 There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop.

(a) Is present data receipt and handling centralized? What are the advantages and disadvantages?

(b) Could a new system (i.e., new satellites, etc.) be designed for distributed data, data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

Response: There are other persons more qualified than I to answer this question.

Question 7 There is a need to clarify how remote sensing data could or should be priced.

(a) For a Government-operated system, should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

Response: Probably for some time there should be a differential pricing structure, because not all users have the same relative entry costs to the new technology. Deacon, Simonett and Smith (1978) define a pyramid of users at the top of which lie a small group of large commercial corporations, some federal government departments, and some large research universities operating under federal funding. At the base of the pyramid, in much larger numbers, lie state governments, county governments, the less developed countries, and small teaching institutions. The ability to pay is correspondingly stratified and a differential pricing policy is necessary in order to allow those at the base of the pyramid to both enter and remain as users of remote sensing data. There is no doubt that for some users the present pricing structure, with its significant subsidy, is required for entry into the new technology. Even for the most sophisticated and demanding users it is clear that the present pricing structure was, indeed, necessary some years ago. The subsidy has been necessary even for these groups. Deacon, Simonett and Smith argue that the prices which could be borne by the public sector could be determined through use of demand-revealing structure techniques currently being experimented with by economists. To my knowledge no such analysis has yet been performed by NASA or any other federal agency. In addition to a differential pricing structure based upon ability to pay, the price should also be time-dependent. Data needed urgently and supplied promptly should carry a premium price. There is no intrinsic reason why different spectral bands should not be priced differently, though it would seem to be an unnecessary complication. Rather it seems more reasonable to anticipate that the output of different instruments might be differentially priced.

The processes of determining a price structure should include the use of Demand-Revealing Processes and Cost Benefit Analysis.

I am strongly prejudiced in favor of continued federal subsidy for a further period of at least five years in order to nurture this new technology. The division of the subsidy between space development, space and ground operations, and reproduction costs, should be subject to regulation, review, whether the system is private sector or government operated, at probably five-year intervals. Subsidies should be acknowledged as such and could be differentially applied to the different parties. As noted repeatedly above, those receiving the highest subsidies could include developing countries, universities, and state and county governments, based on an ability-to-pay criterion, and to deliberately stimulate further research development and applications in these sectors. The transfer payments so arrived at could be directly treated as being attributable respectively to foreign aid, basic and applied research, and state and county revenue-sharing.

Question 7 (b) If the government is going to run a system, should it recover costs? In the future? What about amortising sunk costs for hardware or development?

Response: I believe it is essential that the government should recover a larger share of costs, than it has with the present, essentially experimental, systems. A move to a significantly larger component of cost recovery under prodding by OMB, is premature. The diffuse, but growing market needs a longer period of deliberate subsidy and a sudden escalation of costs could turn off the technology. The subsidy, however, must clearly be phased out over time, or if retained for some users, be severely restricted. Sunk costs for hardware and development should normally not be amortised since they are essentially research and development of the sort that the federal government must maintain in order to stimulate new technologies. However, once a basic operational design has been frozen and multiple satellite hardware is available, the operational system should be fully amortised if possible. However, it would be premature to apply full cost recovery in one fell swoop. The appropriate procedure would appear to be to step up cost recovery of the ground operations, then next the space operations, and finally the amoritization of hardware.

Question 7 (c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

Response: I do not see how the government can avoid prescribing guidelines at the very minimum, and believe it is more likely that they will need to promulgate regulations concerning data prices. I see no way around hard bargaining coupled with flexibility on a wide range of issues including cost sharing, rights to a federal share of profits, insurance against hardware losses, and development and launch of proprietory instruments or placement in orbit via space shuttle. Pricing structures are just one part of a very complex whole which will need to be bargained about.

Question 8 The following questions do not have to be considered LANDSAT specific, but can be viewed as pertaining to remote sensing from space in general. (a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administrations?

Response: I think both administrations have been slow to seize substantial initiatives but I would not go so far as to argue that they have thrown away major opportunities to other countries - yet. However, I think the time is rapidly approaching when the U.S. must take the initiative if we, rather than other nations, are to reap our fair share of the benefits from space. In his foreword to the National Academy of Sciences publication Resource Sensing from Space: Prospects for Developing Countries (National Academy of Sciences, Washington, D.C. 1977) Harland Cleveland makes the following points:

> Other nations will remain reluctant to harness themselves to remote sensing technology as long as the United States has not given formal assurance of the system's continuity. Since the technology is still in an experimental phase and may take some years to become fully operational, the world is waiting for some clear indication from the United States that the system is to be a permanent part of the government's business. The Congress could clear up the ambiguity when it considers legislation to assign the system as a permanent function to some established, or specially created, agency of government.

(Parenthetically, I would add that in my view a private corporation operating under clear guidelines and regulations promulgated by the federal government, would be as satisfactory as a federal agency. D.S. Simonett).

Cleveland continues:

> Thus far the United States alone has financed the R & D and operation of the space segment of the system. But once it is clearly a permanent part of the international picture, some financial contributions could probably be secured in return for a real voice in decisions about management and about follow-on technologies.

(Cleveland is arguing for an international system. Private U.S. corporation operation of U.S. satellites is, in my judgment, no barrier to internationalizing such systems. The COMSAT experience in international space communications, while not a complete analogy, is appropriate).

> Remote sensing technology is still in its infancy, and some important decisions yet to be taken need to be carefully considered to make sure they fit into a phased approach to internationalizing the system.

Cleveland continues:

> It is important to make the following decisions soon:
>
> A public commitment now to the eventual establishment of an international regime. The U.S. should begin forthwith to develop its own proposal for such a regime, and conduct our own remote sensing affairs meanwhile so that they are compatible with later internationalization.

(To allay the fears and suspicions of other countries, particularly the developing world, some form of internationalization, even in the context of private corporation operation of the system appears necessary. That such can be managed has been proven already in the COMSAT experience.)

> A move (requiring Congressional action) to ensure continuity of coverage and transmission to users of remote sensing data. A U.S. declaration of intent to proceed with further development of the technology would reinforce the presumption that remote sensing of earth resources is here to stay.

(This comment was made four years ago. That these hearings are needed now and that no decision has been made by either the present or immediately preceding administration in this area indicates a real need for a presidential-level decision).

Question 8 (b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Response: I would almost say that an operational system is now being considered almost in spite of the federal government. The prime policy decision seems to have been of delay, in the hope that a clear answer would emerge. In some respects the clear answer has emerged. Foreign governments are making commitments to remote sensing, despite the failure of the U.S. government to capitalize on its own initiatives and to develop new initiatives. The major oil exploration and mining corporations have subtantially developed their own remote sensing operations and have vigorously supported the GEOSAT Committee.

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

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GRADUATE DIVISION   SANTA BARBARA, CALIFORNIA 93106

September 8, 1981

To: Congressman Ronnie G. Flippo
Chairman, House Sub-Committee on Space Sciences
and Applications
Suite 2321, Rayburn House Office Building
Washington, D.C. 20515

Attention: Ms. Terese McDonald

From: David S. Simonett
Dean, Graduate Division
University of California
Santa Barbara, Ca. 93106

Re: Response to Senate Sub-Committee Questions on the Hearing on Civil Land Remote Sensing Systems

Question 1. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

Response: Our policy in the past might more properly be stated as being one or non-discriminatory distribution of subsidized data. A question now before us is whether a move to the private sector will cause prices to escalate to the level of what a full cost recovery procedure would entail, if present U.S. Government costs prevail. In moving to the private sector we naturally expect costs to be reduced, and cost recovery to be for this lesser figure. However, even with a lesser increment than is posed with full recovery at Government rates, a question which I raised in my verbal and written testimony is the effect of a rapid and substantial escalation of costs on selected parts of the user community. The possibility exists of turning off that community. In my testimony I considered developing countries, U.S. universities and state and local governments. All will certainly be able to absorb some increase in costs. If it is too large too soon it will have serious impact on all three groups. The advantage of a uniform rate is its ease and simplicity of application. As far as I can see that is its only advantage and there are substantial disadvantages of the type mentioned above which flow from such a policy. To summarize, I believe the policy should be non-discriminatory with respect to open access to anybody in the world obtaining the material. If feasible, a differential rate and time staggered schedule of charges should also be established.

Question 2. The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reduction possible?

Response: Cost reduction should be achievable all the way along the line. Some satellites could be put into launch from Space Shuttle. If they can be inserted into orbit from Space Shuttle they may not require anything like the same amount of shake, rattle, and roll testing to which they have to be subjected at present with rocket launches. Operational systems may be able to use a certain amount of off-the-shelf hardware, or could also involve Chinese copies of existing experimental devices. Both would reduce costs, the former markedly so. There are duplicative facilities in a number of locations throughout the Government. Some consolidation of these may be feasible. There may be cost savings also which can accrue from different incentive systems for private rather than public employees. Such an improvement, of course, is not guaranteed, and the burden of proof is on the private sector to demonstration the fact that it is real!

A final area where cost reductions may arise would be as a consequence of effective marketing by the private sector. If there is a significant increment in the number of purchases of remote sensing data as a response to a vigorous marketing campaign, the per unit costs of production may be lessened. Cost savings from this area are likely to be small. The items being dealt with are not manufactured items but very complex information-bearing data, which requires considerable manipulation in processing.

Question 3. Are you aware of agressive marketing by the French for SPOT data?

Response: I am indeed aware that the French are beginning very vigorous marketing of SPOT data in the U.S. I know of one private corporation in the United States which is in fact now negotiating an agreement with the French for the marketing and servicing of SPOT data in the United States.

Question 4. What are your views on single entity operation of the system versus competition for the various segments of the system?

Response: I do not have a knee-jerk reaction against single entity operation or an equivalent knee-jerk reaction in favor of so-called competition. It all depends on the entity, the nature of the competition, and the particular circumstances. Single entity operation of the system after vigorous bidding is one mode. There also are distinct attractions to accepting a bid such as that by COMSAT, to negotiate an agreement to operate the entire system. Whatever the form which is followed, the length of time for the agreement should be long enough to reap respectable profits for the private enterprise. Thus there should be a reasonable expectation of, say, a 10-15 year agreement subject to renegotiation at 4-year intervals. If there isn't some such guarantee I don't see the private parties being prepared to enter as players.

Question 5. What is your assessment of foreign interest and satisfaction in earth resources data?

Response: Foreign interest is quite variable with respect to the first generation remote sensing data, namely LANDSAT. On the other hand it is uniformly high with respect to potential second and third generation devices. Generally speaking the developing world and certain developed countries (namely Canada, Australia, and to a lesser extent, Brazil and South Africa, which have substantial areas and small but very well trained scientific populations, and sufficiently robust economies to make a deliberate investment in spacecraft remote sensing) have a high and continuing interest in the present LANDSAT capability. They also anticipate much greater returns from future satellites. Small countries, cloudy countries, and those whose landscapes are finely segmented - as in western and northern Europe - tend to have a lower general level of interest in present systems, but look to future spacecraft imaging radars to overcome their cloud cover problem, and to the French SPOT and the U.S. Thematic Mapper for the high resolution panchromatic and multispectral data needed for their problems. There is wide interest in possible satellites such as STEREOSAT of interest to the geological exploration remote sensing community.

Question 6. What are your thoughts on combining remote sensing and weather service data into a single system?

Response: I find this possibility of great interest: technically, managerially, and philosophically. In principle, I agree strongly with the notion of a combined system, for collecting, processing and disseminating meteorological, marine, and land resource remote sensing data. I urge very thorough review of all apparent obstacles to combination. This review should seek to establish acceptable ways to overcome obstacles. Technically, and philosophically the idea reinforces the value of multiple data sources in resource evaluation. There are increasing numbers of examples of R&D, in which coarse-resolution meteorological data may be combined with fine-resolution remote sensing data to develop powerful methods of analysis. Examples occur in marine sensing as well as over-land sensing. In my judgment, decades hence, the decision to combine will be seen to be a major step in the growth and maturation of the field.

Mr. **Flippo**. Perhaps we would go ahead and receive the testimony of Mr. Craib and then begin our questions.

STATEMENT OF KENNETH B. CRAIB, PRESIDENT, RESOURCES DEVELOPMENT ASSOCIATES

Mr. **Craib**. Thank you, Mr. Chairman.

As with Dr. Simonett, I have already submitted a statement for the record. And I will only comment on a few points that seemed to come up in testimony yesterday.

First is that civil land remote sensing has been a reality since 1972, and we have, in fact, had demonstration and pilot projects throughout the United States and around the world. These projects, at least the ones that I have seen, have usually demonstrated cost effectiveness ratios on the order from 1.5 to 10 to 1. And it would then seem a little strange that remote sensing still seems to be a technology in search of a market.

And a valid question is why Government subsidies still seem to be required. I think there are several answers to this.

First is perhaps in our definition of the term "operational." An operational system for a geologist may mean once-a-year coverage. Geology changes slowly. For an agronomist or agriculturalist who is concerned with evaluating, predicting, crops, and their impact on a nation's economy, he has to have repetitive coverage. He has to be assured of continuity of coverage and continuity of the data flow before he invests major amounts of funds in an information system.

And in this context, remote sensing is not an information system; it is a data source and is one among many.

One speaker yesterday noted also that developing countries have no choice, but to use remote sensing because of its wide coverage and low cost. I think I would disagree with that. There is always a choice. These choices will be constrained by budget and by time and by social realities and political considerations, but there is always a choice. This choice may be just to get at what he has. And quite often, that is the choice that is taken.

Remote sensing may well be less expensive than other alternatives for complete coverage of his country, but they also may be more expensive than his budget will permit either in terms of total cash or in terms of displaced jobs.

In a country where unemployment is extremely high, it is often difficult to explain why we are bringing in a capital-expensive technology even though it may be less expensive than any other alternatives that can reasonably be constructed.

The major concerns that I have seen around the world for remote sensing have been the matter of continuity of data which we have discussed at some length yesterday and the price of that data after major funding or system commitments have been made. It is not clear to us exactly how NOAA will determine costs to the individual users at this time. We understand in part which is based on estimates of the amounts of data that major Government users are expected to purchase.

However, Government users face a unitary elasticity of demand for data in which their demand is constrained by available budget. They have a definite incentive to spend whatever budget funds they have established and an incentive not to spend less than what they have.

If the price of data increases, then they do not have the option of obtaining more funds within that particular year. Therefore, they will spend their same dollars, but purchase less total data. How, then, does NOAA intend to recover the balance of those costs, those operational must costs? Will these be passed on to other users? Are we talking about a multitiered system?

One way to find out is, of course, to let the market decide. In talking with some people within NOAA, we have been told that no one has any idea what the market will bear. I think this is fair. No one has done any studies on the price elasticity of demand for remote sensing data or information. That is certainly a valid point.

We have two ways of finding out what these things are. One, we can, in fact, let the market decide. We can go ahead and establish a civil service and see what happens. I would wonder what the consensus might be if we find out it is ineffective without Government subsidies and have to go back in and do this.

The other thing is we can do market studies, but in the absence of any market experience as to what these data are going to cost and what the real cost of recovery should be, we have to make some assumptions. And as we have seen in a variety of studies done to date, the assumptions you get in any study are a direct function of the assumptions you are willing to live with.

I think that concludes my comments.

Mr. FLIPPO. Thank you very much.

[The complete prepared statement, plus answers to questions asked of Mr. Craib follow:]

Statement of
KENNETH B. CRAIB
President and Chief Executive Officer

RESOURCES DEVELOPMENT ASSOCIATES

before the
House Subcommittee on Space Science and Applications
and the
Senate Subcommittee on Science, Technology and Space

Joint Hearings on Civil Land Remote Sensing Systems

July 23, 1981
Washington, D.C.

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RESOURCES DEVELOPMENT ASSOCIATES

STATEMENT

Introduction

Mr. Chairman, I appreciate this opportunity to appear before you to discuss the economic issues of an operational civil land remote sensing system. As a physicist who was privileged to be involved in the development of remote sensing technology from aircraft and space platforms, I am proud of our technical achievements in this field over the past twenty years. As an economist concerned with resources development and management in the developing countries of the world, I am particularly concerned with the cost, availability and utility of information. The record of remote sensing technology as an operational and economic resource information system is not entirely clear.

The objective of any natural resources survey or assessment program is to provide a decision-maker with more complete, more accurate, or more reliable information than would otherwise be available. This information is then of economic value to the extent that it enables the decision-maker to reach a "better" decision than he could in its absence. Remote sensing from aircraft and space platforms offers a new approach to data collection, and in some cases offers new and unique data, difficult or impossible to obtain by alternative means. The key questions are how valid and reliable are these data, and what costs are involved in their utilization? These questions must be answered before any valid assessment can be undertaken of the market for remote sensing technology and services.

In this context it is important to recognize that no "consumer" really needs remote sensing. He needs information, on the nature, extent and time rate of change of the resources at his disposal and for which he has managerial responsibility. This "information" may come from an educated guess or a detailed enumerative survey. His choice will be constrained primarily by considerations of budget and time, and by the possible impact of a "wrong" decision. The perfect decision, reached either by blind luck or through perfect and complete information, leads by definition to maximum benefit to the individual and/or to society. The relative value of an executive is in his ability to reach a "correct" decision based on less-than-complete information, and with the lowest possible information cost. Thus, even if the marginal cost of information approaches zero, a consumer will still purchase only that amount required to reach a decision.

Remote sensing technology is only one source of data among many available to the resource manager. He will select this technology only if it

1. provides him with needed information not possible to obtain by alternative means, or
2. provides the same information as alternative means but at less cost or in a more timely fashion.

Cost is obviously a key factor in this selection process, and remote sensing technology offers the promise of lower data collection costs. In many cases, however, the costs of data collection may be small compared to the costs associated with introduction of a new data type in the resources management decision matrix. This may require substantial commitment in terms of support equipment and services, institutional and organizational change, and replacement of techniques and methods of long standing and known reliability.

A 1977 study by the National Academy of Sciences concluded "Space remote sensing still faces a protracted period of technical development. There is a parallel lag in the responsive adjustment of human, social, and political instruments by which the technology will be harnessed to useful ends. While the technology in its early form already shows many uses, its ultimate technical shape and social worth may not be apparent for another decade or longer".

This timetable would establish 1987 as perhaps a reasonable target date by which to establish the "social worth" of space remote sensing technology. In many respects, this timetable still seems reasonable.

The Issues

Justification for the use of "Landsat" technology, or remote sensing from space, rests on three major points or claims:

1. Landsat can provide more data about earth resources than alternative systems,
2. Landsat can provide unique data, impossible to obtain by alternative means, and
3. these data may be less expensive and more accurate than that from alternative sources.

As we have seen, in the case of data, more may not be better. The marginal value of data may be zero, and in fact could be negative if the consumer is required to process more data than he needs. Similarly, there are relatively few cases where unique data are essential. Although there may be many instances where we would like to have it, there are fewer cases where we "must" have it, and then costs and utility considerations remain. The third argument addresses the issue of costs and expected results. If Landsat technology is to be widely accepted and incorporated into "operational" resource management systems, it will be because the marginal value of its product exceeds the cost of data collection, analysis, and incorporation into the decision-making process.

The Questions

The marginal value of remote sensing technology is a subject of substantial interest to both producers and potential consumers. A series of conferences on "The Economics of Remote Sensing" has been held since 1977 to specifically address this issue. Although initially viewed by some government agencies as "not in their best interests", these conferences have continued to provide a platform for discussion and are now widely supported in principal.

One major topic at these conferences has been the often widely varying results of cost-benefit and cost-effectiveness studies of remote sensing technology, presumably based on the same input data. The answer has been found to lie with the basic assumptions concerning the technical capability of the space system itself, and with assumptions regarding the price elasticity of demand, either for natural resource product or for information about that product. As a general rule, heroic assumptions in any area tend to produce equally heroic results.

Most econometric models used in these studies have been of the inventory adjustment type. Such models are appropriate where production levels cannot be easily changed in response to output or demand predictions, but where inventory holders can adjust their stocks. This is generally the case for agricultural production, and particularly for grain crops. Since seventy percent (70%) or more of the benefits from a spaceborne land remote sensing system are expected to occur in this area, use of these models may be appropriate. There remains considerable debate regarding assumptions of technical capability, price elasticity, and the availability of alternative information.

Price elasticity of demand is an economic term referring to the manner in which consumer demand for a product, in this case data and/or information, varies with changes in the price of that product. In general, as prices increase, less product will be demanded; as prices decrease, more product will be purchased. Demonstration programs and pilot projects conducted in several countries have established that remote sensing from space can provide both useful and needed data regarding natural resources and our changing environment. The technology is routinely cited as having great promise. It would seem, then, that if remote sensing data is equal or better in quality, quantity, or other desirable factors than data from existing alternative sources and costs substantially less, then an equally substantial market should exist. Why then does remote sensing still seem to be a product in search of a market? Why does government subsidy still seem to be required?

Some Answers

Experience to date suggests several answers. First, as noted earlier, the cost of remote sensing data may be a relatively small part of the total "cost" of its utilization. In the more developed countries, such as the United States, massive organizations and elaborate networks of people and machines have emerged over a period of many years to provide information concerning the state and dynamic well-being of our environment and renewable resources. While these systems may be expensive and imperfect, they do their job with known cost and reliability and we have found their "benefits" greater than their "costs". To replace such organizations and systems with a new and alternative technology is not a simple matter. There is obvious human impact and perhaps understandable bureaucratic friction. The consequences of a "wrong" decision affecting hundreds or thousands of jobs is certainly a matter of administrative concern, and there is always the thought that perhaps "the devil you know is preferable to the devil you don't". Under such circumstances, a less-than-immediate rush to enbrace remote sensing technology might be understandable.

Similar problems exist in the developing nations of the world. Even if Landsat technology were shown to unquestionably be the most effective way to obtain resource information, it may not at all make economic or political sense to adopt it in a country where labor is cheap and plentiful and capital is scarce and expensive. The social costs of massive unemployment may be an item of overriding concern. Any decision to employ a technology that either is or appears to be capital-intensive must be both carefully weighed and politically defensible.

Another problem more clearly identified with government agencies than individual consumers is that of unitary elasticity of demand. It has been suggested that such agency demand for resource information or data may be more a function of available budget dollars than unit price. Budgets for data purchase are established well in advance, and it is difficult to spend more than a predetermined amount. Similarly, the agency has a definite incentive to spend all of its budget allocation, or face a possible reduction in funds in subsequent years. Within limits, then, agency demand for data may be a function of its budget rather than the marginal value of the data itself.

A fourth major constraint to development of a space remote sensing "market" has been the uncertain future of the United States program. The majority of "benefits" are expected to come from applications in the agricultural sector. These applications require substantial amounts of data at several points in the crop growth cycle. This in turn requires substantial commitment in terms of men and machines to analyze and utilize these data. In the absence of any assurance that these data will in fact be collected and delivered on time as required, it is not surprising that private industry and foreign governments alike are reluctant to discard present information systems and invest heavily in a new one. A listing of major users of remote sensing data tends to support this argument.

A 1980 report by the National Science Foundation noted that "Private sector companies ..... in the oil and mineral industries have recently expressed interest in the commercial exploitation of earth resources satellites ....". The oil and mineral industries have certainly expressed such interest, but it is hardly new. In 1969, fully three years before the launch of the first Landsat satellite, the president of a major U. S. oil company offered to fund the development and launch of a commercial earth resources satellite. When this offer was rejected, he then requested permission to use, at his expense, certain high altitude aircraft which were at that time viewed as candidates for declassifiation. This permission was also denied, and both projects were subsequently undertaken by agencies of the U. S. Government.

The oil and mineral industry remains a major user of remote sensing technology in part because of the nature of their "target". Many geologic targets of interest are sufficiently large that they can in fact be better seen from space than from ground level. Further, and of particular importance to the present argument, surface geology changes slowly. Last year's data looks much like today's, or tomorrow's. For many applications, repetitive coverage is a low priority and continuity of data is not a major concern. Geologists might then be able to accept the present system as a data source, while agronomists might not.

Conclusions

The principal conclusion to be drawn is that while the technology of remote sensing from space is an operational reality, the routine use of remote sensing data is not. Given a developing but uncertain market, constrained by factors beyond the control of private industry, an unsubsidized privately owned and operated system would seem to be premature at present.

The uncertainty of this market is reflected in the current NOAA pricing policy for Landsat data. As we understand it, the NOAA price formula is designed to recover operational and maintenance costs (OMC) only. NOAA has essentially estimated what their total OMC will be, divided this by the expected volume of customer sales, and arrived at unit prices for data. This approach does not really consider the "demand" side of the supply-demand equation. No one knows if demand will increase if prices decrease, or decrease if prices increase. As one source within NOAA recently remarked in justification of their proposed pricing approach, "No one has any idea what the market will bear".

RESOURCES DEVELOPMENT ASSOCIATES

HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
Questions for Land Remote Sensing Report

July 23, 1981

1.(a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

Agriculture requires frequent and repetitive coverage, but has little requirement for stereo data. Geological applications could benefit from stereo data, and do not require as frequent coverage as agriculture. Weather data in general may have lower spatial resolution than is desired for either agriculture or geology. It would be difficult to optimize a single satellite for both weather and earth resources operations.

2. (a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

Operational implies that data be reliably and regularly available. The present Landsat system may be "ready" for operational use but is not now an operational system.

(b) What is the applicability of LANDSAT D to an operational system?

The same statement applies. No one has yet tried to use "Thematic Mapper" data from space.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80s with the present approved program?

No.

3. (a) By what process should responsibility for remote sensing move to the private sector?

For a variety of reasons, I do not believe that responsibility for the entire remote sensing from space program should move to the private sector.

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the question of finances)?

Yes.

(c) Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

No.

(d) How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

To date, no adequate studies have been done of the market for earth resources data, nor of the price elasticity of the demand for these data. It seems premature to discuss the amount of any government subsidy for services in the absence of definitive information concerning the demand for these services.

(e) Is a copyright provision necessary for private sector operations?

No.

(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

This would probably depend on the degree of private sector involvement.

(g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

(h) How should a private sector operator be regulated, if at all?

(i) Who should do R& D? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

(j) How should the sale price for government equipment be determined for a transfer to the private sector?

(k) If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

(i) With respect to continuity?
(ii) With respect to technical development?
(iii) With respect to market preparation?

For reasons stated earlier, I do not believe the private sector should operate an independent reconnaissance system in space.

(l) What would joint ventures between government and businesses contribute to the present system? Is legislation necessary to permit joint ventures?

Outside my area of expertise.

4. Universities are currently involved in research and training in the area of remote sensing. How is the contribution of universities important? What should be the role of universities in the future, i.e., if we have an operational system? What should be the role of the Federal government vis-a-vis universities? How would

4. (cont'd)commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

I believe others are better qualified than I to comment in these areas.

5. Satellite data is being utilized to provide data for public services. How is the utilization of remote sensing data important to the public welfare and health? To what extent are State and Local governments utilizing this data for public services? What are the primary concerns of the state governments (i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3? (ii) with the future commercialization of land remote sensing?

I believe others are better qualified than I to comment in these areas.

6. There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop. Is present data receipt and handling centralized? What are the advantages and disadvantages? Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

I believe others are better qualified than I to comment in these areas.

7. There is a need to clarify how remote sensing data could or should be priced. For a government-operated system, should there be a pricing structure? For example, should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined? If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development? For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

In the absence of marketplace experience, a study of some sort of the differentiated demand for Landsat data should be undertaken. A primary purpose of such a study would be to estimate demand and price elasticities for different segments of the market as a function of timeliness of data delivery, quality of data, etc. Until this has been done, then any answers to these questions are purely guesswork, based on unsubstantiated assumptions.

8. (a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

No.

(b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

The most important positive policy decisions include our position before the United Nations regarding the freedom to "sense" from space, our policy of open and non-discriminatory distribution of data, and the decision to place operational responsibility for the Landsat program within NOAA. The most negative policy decisions have been the NASA funding limitations leading to the present gap in Landsat data continuity, the lack of backup systems, and the NOAA budget limitations that would seem to make it impossible for them to discharge the operational responsibility they now have.

RESOURCES DEVELOPMENT ASSOCIATES

Senate Subcommittee on Science, Technology and Space
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

Hearing on Civil Land Remote Sensing System
July 23, 1981

Response to Specific Questions
by
Kenneth B. Craib, President
Resources Development Associates

1. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

Discrimination in distribution of data from remote sensing satellite systems comes in two forms: restriction of physical access, and differential pricing policy. The United States has taken a clear position before the United Nations regarding the freedom of information and the right to both "sense" from space and to disseminate data so collected without physical restriction or limitation. In all fairness, this is still a topic of discussion in some areas, but it is a point on which this nation has at least taken a firm stand. Since we have done so on relatively few points of international policy in recent years, perhaps we should cherish this one.

We know that the actions of one nation regarding air or water pollution, overfishing of migratory stocks, deforestation with consequent environmental change, and similar factors can have a direct and serious impact far beyond national borders. The global environment that we all must share cannot be evaluated or monitored piecemeal, and it is generally accepted that information regarding changes in and impacts upon common resources should be commonly available.

We also believe that in a free market society, net social benefits are maximized when resource information is widely and freely available. It would then be in the best interests of the United States to see that resource and environmental data is available to any who can use it.

The United States has followed a differential pricing policy for Landsat data in that it has subsidized "principle investigators" and foreign governments through direct grants and loans. This was initially done by agencies such as NASA to encourage investigation into the utility and application of these data and to publicize the results. More recently, it has taken the form of international assistance to less developed nations concerned with regional resources management and environmental monitoring. This would seem to be clearly in our national interest. To the extent that Landsat data can assist such nations in resources management and use, "subsidy" of this sort would appear to be a very legitimate part of our foreign policy and one that should continue.

Objections to present U.S. data distribution policy have often cited issues of sovereignty, privacy and national security. Given the current and near-future resolution capability of Landsat systems, these concerns seem in general to be "smoke screen" issues of use primarily at the negotiating table. The principal concerns of foreign users continue to be utility, cost, and continued availability of data.

These are also the principal concerns of private sector users. In the private sector, however, discriminatory or non-uniform distribution of data and information presents an opportunity for private gain and profit maximization.

In summary, we feel there are few advantages and substantial disadvantages to changes in basic U.S. policy of non-discriminatory distribution of data.

2. The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

Cost reduction can always be achieved by reducing services or shutting down entirely. I believe a more appropriate question would be how to increase "profits" or at least minimize net operating losses. Given that the current data production/reproduction system is operating at less than full production rates, then losses may be decreased by either reducing costs with current production (improving efficiency) or increasing production with current physical plant (increasing sales).

We seem to have general agreement in the remote sensing community that (1) the principal benefits from and demand for Landsat data lie in the agricultural sector; (2) this demand is presently well below anticipated levels, due primarily to delays in data delivery and lack of assurance of continuity of data. The costs of establishing and operating an agricultural resources information and management system based on or significantly relying on Landsat data are far greater than the costs of the data alone. Given the present uncertainty regarding the future availability and price of satellite-derived data, the slow rate of operational acceptance of these data is at least understandable, if not commendable. If these uncertainties in supply were removed, the general concerns is that demand would increase. If demand increases, then present satellite data system operating and maintenance costs are spread over a larger base, marginal revenue increases and "net operating losses" are decreased.

In the area of direct operating cost reductions, it has been suggested that since the NASA Landsat and NOAA GOES programs were developed and administered separately, duplicative facilities have evolved. If excess capacity does indeed exist, then combined operations could produce significant cost savings.

3. Are you aware of aggressive marketing by the French for SPOT data?

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The French have been active in Africa, pointing out to the Government of Upper Volta and Kenya that they would be "unwise" to rely on a continuing U.S. (Landsat) satellite program. They have reportedly reached agreement with Canada for SPOT data reception and Canadian distribution. A U. S. firm has undertaken a review of the U.S. market under contract to the French, and a "market development plan" is being prepared.

4. What are your views on single entity operation of the system vs. competition for the various segments of the system?

If we ignore for the moment design and launch operation, then the earth resources satellite "system" can be considered in three "segments": (1) operation of the satellite, data downlink, and preparation of HDDTs, (2) preparation of CCTs and film masters, (3) special processing, training, "value-added" services. The United States Government operates exclusively in the first two areas, and participates in the third together with over one hundred private U.S. companies and non-profit organizations. Preparation of CCTs from the "original" HDDTs is a more complex operation, but there are at least ten major U. S. firms that presently have this capability. Although there is no guarantee that these companies would choose to enter this market, competition is certainly possible.

Competition is much more unlikely in the area of satellite operation, data reception and preparation of HDDTs. While several companies might well compete for the rights to operate this segment of the system, simultaneous operation by more than one entity would not appear to be practical. Given that a single organization will be responsible for this segment of the system, the key question is should this organization be a government agency or a private firm?

There are several major differences between operation of an "earth resources remote sensing" satellite and a "communications" satellite. The principle difference is that communications satellites do not have the capability to directly and indescriminantly monitor human activity. The resolution of the present Landsat system is marginal for this purpose, but will improve significantly in the near future. Prior to the advent and universal adoption of the term "remote sensing", this type of earth resources monitoring was referred to as "economic reconnaissance". Only the terminology has changed.

The reaction of foreign governments to a private-sector operated Landsat could be substantial. In the past, several nations have expressed concern about the U. S. policy of universal data collection and distribution. Transfer of key elements of data collection from a U. S. Government agency to a private firm might be expected to trigger further expressions of concern, if not protest. There is also substantial concern within several sectors of private industry, particularly if the private firm selected to operate an earth resources satellite system should be involved in any way in the value-added services business.

5. What is your assessment of foreign interest and satisfaction in earth resources data?

At present there is much more foreign "interest" in earth resources satellite data than "satisfaction". The primary reason seems to be infrequency of coverage and delays in data delivery. While these factors may not be of major concerns for geological applications, they are essential in agricultural applications. Further, in the absence of any assurance that data will be regularly available in the future, few nations are willing to commit major funding for resources monitoring or management program based in whole or in part on Landsat data.

6. What are your thoughts on combining remote sensing and weather service data into a single system?

There seems to be little reason not to combine remote sensing and weather service data into a single system, if that system is operated by a government agency. The programs have so much in common that any other course should be less than efficient. This "combination" was seen by many people as the logical reason for placing Landsat operational responsibility within NOAA in the first place. If the system were to be operated by private industry, however, then the concerns expressed in answer to Question #4 would be considerably increased.

7. Please describe in a little more detail the work you have been doing on the economics of an operational system?

My work on the "economics" of remote sensing systems has been directed primarily at the cost-effectiveness of remote sensing technology, as opposed to cost-benefit analysis. Cost-benefit analysis emphasizes the "net social benefits" expected to accrue, and requires that major assumptions be made regarding the data market and price elasticity of demand. Small differences in these assumptions lead to large differences in total benefits predicted. Cost-effective analysis is more restricted in that it considers a specific task or tasks that must be done and evaluates the costs and relative effectiveness of alternative approaches to task completion. This approach excludes consideration of any "benefits" of remote sensing other than those required by the specific job, and thus usually results in a smaller total benefit figure. On the other hand, it places much less reliance on market assumptions and is less susceptible to error.

I have been directly involved with remote sensing technology since 1964, initially as an Aerospace Technologist and physicist at the then NASA Manned Spacecraft Center, and subsequently as a physicist and economist with private industry. The majority of my work has involved the economics of alternative approaches to resources information and management in the developing countries. Since 1977, I have served as Co-Director of a conference series on "The Economics of Remote Sensing and Information Systems".

Mr. **Flippo**. Senator, I know you may be expecting a phone call so if you would like to take the opportunity at this time to question, I will yield the gentlemen.

Senator **Schmitt**. Thank you very much, Mr. Chairman. I have no idea when that phone call may come through, but I will take advantage of your courtesy.

Let me differ in just one small detail so us geologists aren't left out in the cold on repetitive coverage. You never know which set of photographs, under what lighting conditions, what vegetation conditions, what nature conditions, are going to give you the clue you need in order to do something useful from those photographs. So repetitive coverage is not necessarily foreign to geological interpretation. The fact is I think almost everybody is going to find repetitive coverage is a lot more valuable than we think of today because we still have our head in the aerial photographs. We got one shot, and that is what you worked with.

Mr. Simonett, you have strongly emphasized the need for subsidies in some parts of some sort to make the system viable. What types of subsidies—and I put that word in quotes—do you feel would be best to support an eventual self-sustaining private system? Are you thinking in terms of actual Federal subsidies or cross-subsidization within the industry itself or what?

Dr. **Simonett**. We presently have a subsidy; it is not acknowledged as such.

Senator **Schmitt**. We don't have an operational system, and that's what we are trying to get.

Dr. **Simonett**. That is correct. The ability to pay is differentially distributed among the various users. And if we were, for example, to strike a single price, the universities presently are spending between 3 and 5 percent of their research budget on acquisition of this data. A sixfold increase would shift that to 30 percent.

The research must go on. But it means less research will be done. It also means less graduate students will be supported. That is the concern that I have.

Maybe a subsidy mechanism could be set up where universities get access at a lower price or money could be added to, say, the National Science Foundation and NASA for the specific purpose of enabling universities to purchase this material through the private sector, I don't know which approach would be most suitable.

Senator **Schmitt**. What was the basis for your fivefold or sixfold increase?

Dr. **Simonett**. That is the estimate of what the differential costs are that NOAA is talking about at the moment.

Senator **Schmitt**. That is what NOAA is talking about?

Dr. **Simonett**. It is of that order.

Senator **Schmitt**. Do you know of any private sector estimates on what the cost of data is versus projected cost of data? That is projected versus what it is today.

Dr. **Simonett**. No, I do not. Mr. Craib may have an answer to that.

Senator **Schmitt**. Mr. Craib?

Mr. **Craib**. No.

Senator **Schmitt**. One of the presumed advantages of getting it out of the Government is some efficiencies of scale and efficiencies of operation that the Government seems to have some difficulty in establishing.

Dr. SIMONETT. That was certainly the point that was made yesterday by one of the witnesses. They anticipated they could supply MSS-type data with the scout-type system at a price that would be very competitive.

Senator SCHMITT. Do you know of any estimate on what the total subsidy that exists today is? Is there any estimate of that? What is it costing the Government in order to support a variety of users?

Dr. SIMONETT. The costs seem to range around $30 to $35 million for the ground segment, including the EROS Data Center. The EROS Data Center recovers about $4 million from reproduction of *all* remote sensing data, of which satellite data is roughly one-half. The total expense of running the Center appear to be around $12 million. There is an additional $20 million to NASA's ground signal share. NASA is not charging for its scene masters when they move to the EROS Data Center. If they were properly priced, that would probably be around $300 for each scene master. The EROS Data Center is only passing on a fraction of the real costs for acquisition and duplication of data tapes, and images.

So that is the order. It is at least 6 to 1, and may well be rather more.

Senator SCHMITT. So there is a significant subsidy that already has been approved in a sense by the Congress. I suspect it is even more than that when you look at individual research grants.

Dr. SIMONETT. Yes, indeed.

Senator SCHMITT. And when you also look at what the States have already allocated also. So it could turn out that there is quite a resource of subsidy already in the system. The question is: Would the Congress and State legislators maintain that subsidy if necessary in the face of an operational system?

Dr. SIMONETT. My suspicion is what we have to adopt is a differential timing and pricing schedule for universities and LDC's. The concern is that when you put an impulse function into the system, you can simply head off a technology, one that is very valuable to the LDC's. That is the reason I got into this business in the first instance because I thought it was an opportunity for some of our highest technology to be used in a neutral rather than an exploitative sense or potentially in an exploitative sense. And the LDC's themselves see it that way.

They do have concerns that it is potentially capable of exploitation. But nonetheless, there is a deep sense in the LDC's that it is a relatively neutral technology and potentially advantageous for them.

I don't know what the answers are on timing and the pricing schedules, but I suggest caution in approaching it more than anything else.

Senator SCHMITT. I can certainly confirm your perspective on the LDC's, perspective about the data and the utility of it. It was obvious in 1973 as I traveled those countries and in 1974 and subsequently. I suspect that the feeling is still there today, although we have delayed taking advantage of that opportunity from the standpoint of building new relationships between ourselves and these countries. So it is going to be more difficult because of that.

Thank you, Mr. Chairman.

Mr. **Flippo**. Thank you, Senator.

Dr. Simonett, in the university's usage of Landsat data, are you able to use all of the data that you get from Landsat? If you were purchasing it, would you be able to specify what portion of that data you were interested in?

I understand that there is a lot more forthcoming from remote sensing than we are currently able to use. Is that an accurate statement?

Dr. **Simonett**. I believe it is accurate.

Remote sensing, as Mr. Craib pointed out, is part of a series of emerging parallel technologies, particularly the use of geographic information systems in which one merges a variety of forms of data with remote sensing data, including topographic data and soils map data in digital format.

This is potentially a revolutionary tool for management and analysis. The universities are only just beginning to explore the interrelationships between frequent updates with Landsat and relatively static phenomena such as soil type and topographic data.

In answer to your question, I believe it is in the interaction between dynamic and static components of the environment that some of the greatest intellectual and practical advantages in this area are going to come. Remote sensing is one element of an information and analytical explosion potentially feasible with geographic information systems.

Mr. **Flippo**. So is it fair to say that the value of the Landsat data is unclear at this time in terms of the full value of it may not be known for quite some time in the future?

Dr. **Simonett**. Yes, Mr. Chairman. The figures Mr. Craib mentioned, 1.25 to 10 to 1, were based on a cost-effectiveness criterion and did not anticipate future discoveries. I feel very strongly, that between remote sensing and ancillary data there are multiplier effects of very considerable magnitude. It is very important to be able to overlay various kinds of data.

In geology, for example, we are beginning to use geophysical data in association with Landsat data and to do so by artificial stereoscopy in which one can in effect create a third dimension of geophysical data and bring to bear the eye-brain combination, in inspecting and interrogating data.

I can't give you an explicit direct numeric answer except to say that it will be larger than cost-effectiveness and maybe much larger.

Mr. **Flippo**. While the Landsat moves along, as it moves along, we are talking about an automatic mapper so we will have additional information that we do not know fully how to utilize at the present time; is that correct?

Dr. **Simonett**. Yes, indeed, sir; that is correct. The experimental work that is being carried out with the Landsat-D thematic mapper simulator, is very instructive in this regard. There are people in the audience—from NASA—who, if it seemed appropriate, could address this.

Mr. **Flippo**. Mr. Craib, you said that to your knowledge, no one had conducted any studies of price elasticity. Did I understand you correctly?

Mr. **Craib**. That's correct.

Mr. **Flippo**. There seems to be some confusion, at least there is some confusion in my mind, about what we are really talking about when we talk about cost. Are we talking about development cost? Are we talking about operational cost as far as cost recovery and pricing?

Would you talk about that or elaborate on that?

Mr. **Craib**. In terms of cost to the consumer of the system, the only cost he is interested in, of course, is his operational cost. And in that context, remote sensing data may represent a relatively small, but important cost factor. It may be under 5 percent. We have heard this number before. It may be in the order of 10 percent.

His major cost is in changing his information system if it needs to be changed to accommodate or to rely on remote sensing. And if he does incur these costs both in human reallocation and reorganization costs and whatever, as well as equipment costs, he needs to have some assurance that the data are going to be there. It is going to continue to come. Otherwise, he has invested a great deal of money and lost it.

This has certainly been a major item of concern in the developing countries where I work. There have been several of these countries that were convinced that this system would do a great deal for them in terms of resources, evaluation search, environmental market, and were on the verge of implementing an operational system, but since it appeared that the Landsat system itself was not sufficiently operational to assure continuity of data and since there was no really solid feel as to what would happen with the price, they declined to do so.

Mr. **Flippo**. Mr. McGrath.

Mr. **McGrath**. Thank you, Mr. Chairman.

I believe, at least from what I heard, the key to the transfer of the operations from NOAA to a private sector enterprise seems to be the guaranteeing of markets for the information that is available or become available.

So far as we have heard from representatives of universities who are getting information at a very reasonable price, we have heard that they have international treaties with other countries that provide information at a very reasonable price—nothing—and also State governments that have been getting it at a super-reasonable price.

Where is the market, then, if we are going to continue that policy? Where is the market, then, for private enterprise to be able to market some of the information that they are going to be able to get?

Mr. **Craib**. Well, as regards State agencies or any Government agencies, for that matter, I think most anyone who is looking at the problem would agree any State or Federal agency has a definite incentive not to reveal its pricing preferences. It reveals what its preferences are for data costs or cost savings and faces a possible cut either in budget or subsidy. And, therefore, no one is going to openly give that information. But there are ways of obtaining it.

In terms of the private sector market, there seems to be a little question that there is a major market in the geologic community at the present time. And this has been addressed by private industry and the Federal Government.

Mr. **McGrath**. You are saying there is now?

Mr. **Craib**. I am saying there is now. And the private sector can certainly, I think, do quite well in that area. The geologic community, I think, has evidenced their willingness to get substantially more involved in the Earth satellite-sensitive business.

In fact, as I recall, in 1969, 3 years before the launch of the first Landsat satellite, the president of a major oil company in the United States offered to design, build, and launch his own Earth resources satellite system, and to do so entirely at his own cost if he could use the Government launch facilities. That request was turned down.

But I think it does indicate that there was certainly an interest in the private sector in being involved in all phases and all aspects of remote sensing well before the initiation of the present Government project.

Mr. **McGrath**. If it is in a Nation's interest to provide that information even to the private sector at this point at either no cost or reasonable cost, why would the private sector entertain going into business vis-a-vis the takeover of the program from Government to private practice?

Mr. **Craib**. The present system certainly does not provide data to the private sector at no cost.

Mr. **McGrath**. I didn't say "no cost," but more reasonably by perhaps establishing its own satellite system.

Mr. **Craib**. In terms of data costs, we have both dollar costs and cost of loss of data and continuity of data. And it is in the area of continuity of data that I am most concerned, particularly in the agricultural sector.

Mr. **McGrath**. You have been involved in underdeveloped countries and use of remote sensing. Have we fully used our capabilities in remote sensing as a foreign-policy tool?

Mr. **Craib**. We have provided a great deal of data to the developing countries. We have established technology transfer of programs in a number of these countries. Some of them have done well; some of them have not. In general, where those programs have not done well, I do not feel it is a result of technology of the system that may have existed or changes that may have happened at that particular time.

Senator **Schmitt**. Would you speak up a little bit?

Dr. **Simonett**. Could I comment on that, Mr. McGrath?

Mr. **McGrath**. Be my guest.

Dr. **Simonett**. I don't want the remarks I made on a differential pricing schedule to suggest that I don't think there is a market. I believe there is an emerging and developing market. All I was concerned about was not turning off the development of that market, because the entry costs of different sectors of the pyramid of users are going to be different.

What we are seeing is, for example, a sharp reduction in the cost of computing. Microcomputers are here to stay. As somebody testified yesterday, a $250,000 piece of equipment now may be obtained for around $40,000 to $60,000. That completely changes the perception of the total entry cost into the system.

The other part of this is that this is a truly complex technology which requires a depth and breadth of education to really have access to it. You really need wise old men who have a depth of field experience and a lot of bright young people engaging in the new technology. That takes time, hence my caution with respect to applying a unitary pricing procedure. I'm quite satisfied that there will be cost advantages to the developing world, given enough time.

What we now have is an experimental system which has not delivered timely data, and which has not delivered much sequential data for LDC's, except in a few rare instances in terms of major floods in Pakistan and Bangladesh. It has really not been fully tested.

First of all, it is a one-eyed system. We are dealing with one of a whole series of possible alternatives. We are dealing only with the MSS. Think of all the alternative systems that could have been put up in the past. What we have is a limited test and hence a limited view of the potential of future satellite systems.

Secondarily, there has been no real test in the LDC's of the monitoring role with Landsat. Mostly what they are doing at the moment is simply broad-scale reconnaissance of their resources. There is an array of potentials and possibilities downstream which will considerably change their ability to pay, and their assessment of this as a proper and wise investment. However, they have already made substantial investments in the area in ground stations, in training, and in directing young scientists into the field. They have gambled on the United States providing continuity of satellite data. The magnitude of their investment and commitment is now such that continuity is a serious international political issue.

We also have to take a visionary leap and a gamble even though all the facts are not in.

Mr. **McGrath**. I'm not opposed to rolling the dice. My concern is that we transfer this responsibility, set up some sort of a subsidy program perhaps, and then somewhere down the line, we find out that there is little market for cost. And then we are in the position of having to go back to where we are presently or where we should be.

Mr. **Flippo**. Mr. Hollenbeck?

Mr. **Hollenbeck**. I will pass for now.

Mr. **Flippo**. Senator Schmitt.

Senator **Schmitt**. Thank you.

Mr. Craib, it seems to me there may be some clues to how this market might develop and would lend themselves to some economic analysis. I'm curious whether you have looked at them.

For example, to differ a little bit with Mr. Simonett, I think when we look at the possibility of having believed Lacie with respect to the Russian wheat crop a few years ago, the estimates are we could have gained the American farmer something like $300,000 just by following his predictions rather than the ones that the Agriculture Department was using.

Similarly, there has been a broad aerial survey industry in existence for many, many years which I presume has unit pricing. Mike, nod your head if that is true.

And they certainly have been successful, and it has been an expanding industry for some time. Have you looked at either one of these or other similar kinds of endeavors that are at least a piece of the pie that we are talking about here today?

Mr. CRAIB. Starting in 1977, we have had a series of conferences on economics of remote sensing. We have had people from industry, government, universities, attending these. At the last one, one of the major areas of discussion was cooperation and conflict between government and private industry in the area of remote sensing, specifically in the area of aircraft remote sensing.

There is or has been a fair bit of competition in high altitude aircraft photography business. The position of private industry seems to be that they could in fact deliver a superior product at a lower cost. And that seemed to be supported by the data that was presented in that conference.

Whether or not in fact you can do that with a satellite system has not been established to my knowledge.

Senator SCHMITT. what I'm trying to get at is have you looked at the pieces? I realize it is difficult to evaluate the whole economic foundation that might exist for an operational remote sensing system in the broadest context, but there certainly have been operational systems or at least evidence of what the economics of a portion of an operational system would be—Lacie being one; the aerial survey business being another.

I'm sure there are others that don't occur to me right now. Have you tried to look at those pieces of the pie and see how do they at least as a subtotal relate to the economics of an entire system?

If you could save $300 million every few years or gain it, my goodness, you have done an awful lot of sensing.

Mr. CRAIB. The cost/benefit studies that have been done to date would indicate there might be substantial benefits in these areas, but these benefits have ranged anywhere from 1½ to 800 to 1. And there is serious question as to where within this range of benefits you want to say is the correct number.

And this is a function of the assumptions that the authorities used in doing their studies. The general conclusion seems to be, yes, the system is beneficial. Benefits do definitely outweigh costs. Our costs at the present time, as low as they should be, are they higher than they should be? This depends on the assumptions the individual analysts wish to make. And they make so many wild ones.

Senator SCHMITT. What if we went operational with one or two portions of the system that everybody who has had any feeling for it at all said, "Yes; that will probably pay for itself?" What if we did it in a stepwise fashion?

Mr. CRAIB. It would appear that the MSS system might pay for itself.

Senator SCHMITT. You heard the testimony yesterday. Do you generally feel that that proposal might have some viability within a factor of two or three?

Mr. CRAIB. If the costs of the satellite and launch system are as were presented yesterday, I would think that might be a very cost effective system. The biggest constraint at the present time is not the price of data to these countries, but the continued availability.

If we can guarantee the continued and timely availability and delivery of data with the quality that we have at the present time, then we will see a great number of operational systems because the benefits and value received will definitely exceed that expenditure. At least, this seems to be the opinion of everyone we have talked to in the study so far.

Senator SCHMITT. Gentlemen, quickly before my time is up, would you comment on whether the statutory framework for a private sector operational system or systems should include nondiscriminatory data provision? Should anybody who is willing to pay the price of access to the data?

Dr. SIMONETT. That has certainly been the posture the United States has taken through the freedom of space provisions, and I personally agree with this fortune. However, if you also mean that the private sector would retain the right at all times to duplication of essentially the same work order and reap the same price from it, I would emphasize that there is a substantial "black market" today aleady in existence even with tapes at $200.

Universities quite frequently trade tapes among one another in order to have only the duplication costs on their own tapes, avoiding that $200.

Senator SCHMITT. Is that truly a black market? Is that illegal?

Dr. SIMONETT. No; it is not illegal; it is just a procedure that is widely employed.

Now, the private sector would look rather askance at that, particularly if it was possible to do this in the private sector itself. You could have something comparable to the present record industry which is being deluged with illegal tapes and so on.

Senator SCHMITT. Are you proposing there be copyright law associated with this?

Dr. SIMONETT. I think you have to have some form of copyright or protection of investment, and right to a reasonable profit. I don't see how it can be avoided.

Senator SCHMITT. What about patent law with respect to particular procedures for the use of the information value-added procedures? If you can patent recombinant DNA molecules, is that different?

Dr. SIMONETT. This is a pretty murky area.

Senator SCHMITT. It is one we are going to have to deal with. Clear it up for us.

Dr. SIMONETT. I'm not even sure I have an adequate comment, let alone the wisdom to give a good comment on this particular one.

Senator SCHMITT. Maybe you will think about it. And I would like to have you and our other witnesses think about this issue for our record.

Dr. SIMONETT. I would like to think about it.

Senator SCHMITT. I'm sure we will never draft a piece of legislation or finalize a piece of legislation unless we tackle these issues.

Dr. SIMONETT. It would have to be differentially distributed, in the private sector itself. The prime might have one kind of rights in the data, and then all the ones that followed would have secondary rights to their own. So it would be a diffused kind of a system.

Senator SCHMITT. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you, Senator.

Dr. Simonett, if I might make a few statements in laymen's terms, because that is what I am—I'm not a scientist—you correct me where I——

Senator SCHMITT. You are coming along very well.

Mr. FLIPPO. If I understand the essence of your testimony, you are saying that we receive a large amount of data from Landsat, and because it is in its infancy, we do not know the total value of that data.

How can we better utilize that information? If we set up a system that denies the universities that information or makes it so they can afford only less, we reduce our ability to understand how to more fully utilize that data.

Would you say it better for me?

Dr. SIMONETT. No; I couldn't say it better; you've said it very well. I would like to add that the university is only one sector of the total research and development that goes on in the United States and elsewhere. It is an important sector, however, and it is critical to insure that costs don't swamp us.

Mr. FLIPPO. Then, the other question I would direct to either of you is: Suppose you had a few million dollars a year for research. Would you put the money into research on the ground, learning how to interpret data better, or into development of a new satellite technology, say Landsat aerial or something like that?

Dr. SIMONETT. That is not something that one can give an either/or answer to. A common pattern in putting black boxes up in the sky is that more money goes into putting the black box up and in operational costs, often by an order of magnitude, than goes into research afterward. However if you look at what happens in the private sector and in the university sector, when a new device comes along, the research that is carried out with it may be orders of magnitude larger than the cost of the device itself. That has certainly been the case in regard to laboratory infrared spectroscopy.

The National Science Foundation early took an aggressive posture with respect to funding training in remote sensing in universities. Unfortuntely, they abandoned that after 5 years, and they have not, in my judgment, continued their vision of this as a prime area of technological growth in the United States. They should be investing more heavily in research in remote sensing. They have left that largely to NASA and to some of the other line agencies.

Mr. FLIPPO. Mr. Craib, would you have a comment to make in regard to that?

Mr. CRAIB. If the economic return in any of these systems affects the uses of the data, it seems at least an equal amount should be spent to find out what those uses are and developing the uses as to putting the box into space.

As Dr. Simonett says, we have not done that in the past. We are still in the process of learning what some of these applications are. Many of these applications are really dictated by a low profile in the market.

If I had $2 million to spend, I would spend it on applications.

Mr. FLIPPO. Thank you.

I am pleased to note the presence of the distinguished chairman of the full committee and on Space Science and Application, the gentleman from Florida, Mr. Fuqua. Glad to have you with us. And would the gentleman have some questions for the witnesses or a statement that he would care to make?

Mr. **Fuqua**. No. I came to listen. Thank you.

Mr. **Flippo**. Do you have a followup question, Mr. McGrath?

Mr. **McGrath**. Just one. I don't know why I am always the one that is asking the questions on the business details of this transfer, but something that the Senator said piqued my interest. And that was a $300 million savings or at least a benefit to the farmers.

Senator **Schmitt**. That was the estimate when we were dealing with the agristars issue on the Senate side. We did some research on that, and it turns out in retrospect had we believed the Lacie projections of the Soviet wheat crop, the farmers probably could have realized another $300 million in the price they asked for their wheat.

Mr. **McGrath**. Well, if some contract at that time had been established between whomever and the provider of that information, then certainly that would have been a tremendous cost/benefit to that industry.

I'm just wondering whether one of the markets for this might be established on a base cost, established in a contract, and a contingency based on the cost/benefit.

Senator **Schmitt**. I'm not sure that anybody looking at this system would try to market that to those users that require repetitive use for which this is a service of general utility and then on an occasional basis of great utility in making those kinds of projections.

Mr. **McGrath**. No further questions.

Mr. **Flippo**. Thank you very much.

Gentlemen, we very much appreciate your testimony today. With your permission, we would like to submit additional questions to you in writing for the record.

And thank you very much. Your contribution has been great.

Our next witnesses are Dr. Michel T. Halbouty, consulting geologist and petroleum engineer, Houston, Tex., Mr. A. J. Rosenberg, vice president and manager of the General Electric Division, and Dr. Joseph V. Charyk, president and chief executive officer of Comsat General Corp., our next panel.

If you gentlemen would please come forward—and if Mr. Smith would like to join you at the table—I believe it will be OK.

Mr. **Smith**. No, that's all right.

Senator **Schmitt**. Just as well to leave well enough alone.

Mr. **Flippo**. Dr. Halbouty, we appreciate very much your taking the time to come here. So please feel free to submit a statement for the record and summarize or read as you deem appropriate. We would be pleased to have your testimony.

STATEMENT OF DR. MICHEL T. HALBOUTY, PRESIDENT, MICHEL T. HALBOUTY, INC.

Dr. **Halbouty**. Mr. Chairman, I will submit my written testimony. And I also would like to have the pleasure to read some of it. I have given it a lot of thought, and it would be most apropos for you to listen to some of the things I want to say the way I want to say them.

Mr. **Flippo**. We would be pleased to have your testimony any way you would care to present it, Dr. Halbouty.

Dr. **Halbouty**. There will be some things I will probably add as I go along.

Mr. Chairman and members of the Senate Subcommittee on Science, Technology and Space and the House Subcommittee on Space Science and Application, it is my great pleasure and honor to testify today as a geologist and petroleum engineer who uses remote sensing data routinely in exploration for petroleum, and who is greatly concerned regarding the future of this Nation's civil remote sensing program and its role in the global effort to find mineral and energy resources.

Today, our civil remote sensing program is a shambles because of gross ineptitude and negligent management that stem from lack of clear Government policy and executive direction. The resource community that I represent is alarmed and dismayed that almost 10 years after the launch of Landsat I, and after many years of successful use of Landsat data in the search for petroleum and minerals, that this country has no system which insures that global multispectral data will be delivered to us in a regular and timely manner and in an optimized standardized format.

Furthermore, we are very disturbed that this same lack of Government direction and initiative is extinguishing the research and development that have given the United States a technological advantage in the application of aerospace remote sensing techniques in solving global resource problems.

Now, with regard to civil remote sensing, it is vital to recognize that industry is composed of distinct groups that have different interests. And I am surprised to note that a lot of people didn't realize these different interests exist. These groups are represented by:

One, the aerospace remote sensing industry, which builds space platform sensors and ground processing facilities;

Two, the so-called value-added industries which provide instrumentation and services for processing and analyzing remote sensing data; and

Three, those industries which use remote sensing data in solving problems.

I am speaking mainly as a representative of those industries which use remote sensing data in solving some type of problem. In our view, operational remote sensing data are those that are routinely used by geoscientists for exploration and development of resources. We expect such data to be delivered promptly on a continuing basis and in standardized format optimized for analysis.

An operational system is a system which guarantees delivery of such data in an efficient manner. Thus, the operational system must evolve over time to incorporate more efficient, sufficient proven and low-risk technology so that the highest quality data and services are provided to users at reasonable cost.

Now, experimental remote sensing data are used by a select number of scientific researchers to determine what geological landscape characteristics can be detected and analyzed using remote sensing techniques and to determine potential new applications. An experimental system in this context provides nonstandard data on an irregular basis in a manner which supports scientific investigations.

It should be recognized that research industries are the major users of experimental data for internal research because of the importance of understanding developing techniques and potential applications.

For the past decade, Landsat Multi-Spectral Scanner, [MSS] data have been applied routinely by a broad segment of users in both the public and private sectors to a wide variety of natural resource problems. The Landsat system in this context should have been designated as operational some years ago so that the system technology could have been systematically upgraded to provide four-band multispectral data at 80 meter resolution on a routine and efficient basis.

The resource industries believe that if this commitment had been made by the Government, the aerospace and value-added remote sensing industries would be involved today in directly marketing Landsat data and perhaps leasing part of the Landsat system. However, the past administration compounded and confused the issues of operational remote sensing by designating the Department of Commerce [NOAA] to manage the slow transition to an operational status.

This resulted in a transitional plan and draft legislation which, if enacted, would have insured little private sector interest in civil remote sensing for decades. Clearly, we are now moving in the wrong direction, and it is time to get back on the right track toward establishing a viable remote sensing system.

I have been asked to focus my testimony on whether we should move to a private sector operational system or whether we should proceed with an interim Federal operational system. The implication of this request is that you have to select one of these alternatives. I would like to emphasize that part of the Landsat system is operational now. For 7 years, Government procrastination has delayed an obvious decision.

It is obvious that when the MSS operated successfully on Landsat II, that portion of the system should have been designated operational. We would have had an all-Government program then, but by so doing, we would have stimulated private sector involvement to the degree that industry participation would have been a reality today.

There are many myths that cloud issues related to operational status. I would like to refer to some of these.

One is that if the system is designated as operation while it is under Federal control, industry will never become involved in the operational aspects of the program—or any aspects for that matter. The major factor controlling industry involvement is the element of financial risk. I want to stress that.

By not designating the Landsat MSS system operational 7 years ago (thus defining the proven and low-risk technology) and by creating a Federal maze of agency infrastructure and regulation, the Government has increased the risk so that industry has taken a wait-and-see attitude. The fact is, industry involvement in the operational aspects of a Federal program will naturally occur in our society, if encouraged, by making it highly desirable from both a Government agency and private sector perspective. What we have done to date is to move in exactly the opposite direction.

Another myth is that technology becomes frozen when a system is designated operational. Even though the performance of the MSS has surpassed all expectations, its design is based on 15-year-old optical-mechanical scanning technology. If the Government had designated the Landsat MSS operational in 1975, we would probably be flying a calibrated, solid state, linear array instrument based on the MSS, on Landsat-D. Industry would have probably been a major participant in the development of this improved technology.

A third myth is that when the program becomes completely operational, Government should hand it entirely to industry. Again, it should be stressed that the key to industry involvement is the element of financial risk. Government should conduct fundamental research in technological development which has a high element of risk which requires a longer term investment and which has a high potential for application.

The Government should also test the new technology and methodology, perhaps in concert with users, as it has done so successfully in the joint NASA-Geosat test cast project. Then, if the developed technology is proven to be low-risk, industry will want to use that technology in the operational aspects of the program.

What I am stressing is that technology and science will continue to evolve, bringing forth new ideas, methods, and instruments; therefore, to freeze the program by handing it completely to industry is not sensible at any time in the near future.

Another myth is that because NASA's charter focuses the efforts of that agency on research and technology development, NASA should not be involved in the operational aspects of the civil remote sensing program. That's the myth.

Such an assumption is absurd because NASA is currently involved in the largest segment of the Landsat program. It is the agency which is conducting the major portion of the fundamental research and technology development in land remote sensing, and it has a proven track record in working with the aerospace and value-added remote sensing industries.

To add other elements of the Federal bureaucracy to the civil land remote sensing program will not only increase proliferation of Government and lead to increased Government spending, but will discourage industrial involvement in the program. If NASA's charter does not provide for management of the operational aspect of remote sensing from space, then change the charter. After all, that charter was written 20 years ago. And at that time, we had just entered the satellite age. The Government should be moving toward designating a single Federal agency for civil land remote sensing, not growing from two agencies to three.

Last, another myth that seems to cloud the issue of moving civil land remote sensing to an operational status is that comprehensive legislation and policy are required to cover all aspects of operational activities. I arrived at this conclusion from examination of your rather imposing list of issues that should be considered in establishing an operational land remote sensing system.

Quite frankly, there are many very intelligent people in both industry and Government who can work out the details once the Government makes the commitment to operationalize civil land remote sensing. It is my personal belief that the legislation should be kept as simple and as broad as possible to insure its rapid passage through Congress and, thus, correct past errors.

Let me now turn to an area that deeply concerns the mineral and petroleum industries. That is the area of developing and testing new advanced technology.

Since 1976, the scope of international development in satellite remote sensing has changed dramatically. Foreign countries are aggressively copying our existing systems as well as developing new ones which will employ the latest advanced solid state and microwave imaging technology.

Since 1976, NASA has proposed a series of new experiments to develop and test new advanced technology for global resource investigation. Some of this advanced technology includes multispectral linear array sensors, linear array stereoscopic sensors—such as solid state stereo-capability satellite—advanced microwave imaging systems, and potential field mapping satellites such as Gravsat.

The mineral and petroleum exploration industries urgently need the data furnished by this technology to find the resources we need for the future.

It is my understanding that since 1976, NASA has not been successful in obtaining funding for these technological developments. During the same time, foreign countries have moved aggressively forward in these areas and are planning to launch major new systems for their resource industries by the middle of this decade. If the United States does not move forward to obtain its own data, U.S. industries will be forced to purchase these data from foreign sources.

NASA's role in aerospace remote sensing has always been to conduct the necessary longer term, high-risk (but potentially high payoff) research and technological development for experimental prototype systems. In the last 6 years, that role has been overlooked because of the attention focused on formulating the operational aspects and industry involvement in civil land remote sensing.

With the success of the Space Shuttle, the United States has a unique technological opportunity in this decade to test new concepts and hardware in space at a fraction of the cost associated with the use of free-flying experimental satellites. Yet, NASA programs related to instrument development and testing of Earth observation payloads in the Shuttle are almost nonexistent for lack of funds. I think that's tragic.

This Nation now has a major technological breakthrough. An opportunity of this magnitude may come about only once or twice in a century, and we are failing to exploit it.

There is an immediate and critical need to correct this incredible oversight if the United States is to remain competitive in aerospace remote sensing and in the applications of remote sensing techniques and data to our own, as well as global, resource problems.

In summary, I am recommending the following, Mr. Chairman:

One. There is a critical need to adequately fund longer term, high risk, but potentially high payoff fundamental remote sensing research and technology development within the Government to capitalize on the tremendous technological advantage that the Space Shuttle provides;

Two. The Landsat system should be declared operational, and we should recognize that technology changes in the operational system would occur when proven, low-risk technology is available. Therefore, a level of funding must be established to support that operational status;

Three. The single Federal agency responsible for land remote sensing and the remote sensing industry should together work out the details regarding the best institutional framework and legal arrangements to insure maximum industry involvement in the program;

Four. The Government should be responsible for the high-risk elements of the operational program. This is the state of most of the program now, but the Government's share will decrease as technology advances and industry becomes more involved in the operational aspects of the program;

Five. Industry participation should be encouraged to the highest degree possible by (a) legislation as broad and simple as possible to permit future industry involvement in all types and phases of civil remote sensing activities, and (b) the Government bureaucracy should be streamlined so there is a single Government agency interface. And I recommend that this agency, Mr. Chairman, be NASA;

Six. I want to make it perfectly clear that I consider myself as one of this Nation's strongest advocates of the free enterprise system. And, sooner or later, I would like to see industry take over as much of the civil remote sensing program as possible, including ownership and operation, provided there are no guarantees or subsidies from the Government, and also that any industry involvement will be consistent with the international policies of the United States.

And most importantly, the program is never, never to be turned over to a monopoly. It must be and remain competitive.

The last recommendation and most urgent, I firmly believe that it is imperative that the United States launch as soon as possible a solid state stero capability satellite from which its data would tremendously aid in discovering the energy and mineral resources which are so vital to this Nation as well as to the rest of the world.

Thank you, Mr. Chairman and members of the subcommittee, for this opportunity to be of use today. I hope I talked loud enough for those in the back to hear me.

[The prepared statement, plus answers to questions asked of Dr. Halbouty follow:]

Statement
of
Michel T. Halbouty
before the
Senate Subcommittee on Science, Technology and Space
and
House Subcommittee on Space Science and Application

Joint Hearing on Civil Land Remote Sensing Systems

July 23, 1981
Washington, D.C.

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STATEMENT

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Geoscientists need remote sensing data as an added tool in their exploration efforts to locate, discover and produce the future energy and mineral supplies of this country.

Today our civil remote sensing program is a shambles because of gross ineptitude and negligent management that stem from lack of clear government policy and executive direction. The resource community that I represent is alarmed and dismayed that almost ten years after the launch of Landsat I, and after many years of successful use of Landsat data in the search for petroleum and minerals, that this country has no system which ensures that global multispectral data will be delivered to us in a regular and timely manner and in an optimized standardized format.

Furthermore, we are very disturbed that this same lack of government direction and initiative is extinguishing the research and development that have given the United States a technological advantage in the application of aerospace remote sensing techniques in solving global resource problems.

Before addressing some of the issues related to civil land remote sensing, it is necessary to clarify how our resource industries receive data from the civil remote sensing community and the types of data produced by remote sensing systems. The research industries identify the public sector as federal and government agencies. The private sector includes individual citizens and groups of citizens engaged in joint ventures for monetary return, that is, industry. With regard to civil remote sensing it is vital to recognize that industry is composed of distinct groups that have different interests. These groups are represented by (1) the aerospace remote sensing industry, which builds space platform sensors and ground processing facilities; (2) the so-called value-added industries which provide instrumentation and services for processing and analyzing remote sensing data; and (3) those industries which use remote sensing data in solving problems.

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The resource industries believe that if this committment had been made by the government, the aerospace and value-added remote sensing industries would be involved today in directly marketing Landsat data and perhaps leasing part of the Landsat system. However, the past administration compounded and confused the issues of operational remote sensing by designating the Department of Commerce (NOAA) to manage the slow transition to an operational status. This resulted in a transitional plan and draft legislation which, if enacted, would have ensured little private sector interest in civil remote sensing for decades. Clearly, we are now moving in the wrong direction, and it is time to get back on the right track toward establishing a viable remote sensing system.

I have been asked to focus my testimony on whether we should move to a private sector operational system or whether we should proceed with an interim federal operational system. The implication of this request is that you have to select one of these alternatives. I would like to emphasize that part of the Landsat system is operational now. For seven years government procrastination has delayed an obvious decision. It is obvious that when the MSS operated successfully on Landsat II, that portion of the system should have been designated operational. We would have had an all government program then, but by so doing we would have stimulated private sector involvement to the degree that industry participation would have been a reality today.

There are many myths that cloud issues related to operational status. One is that if the system is designated as operational while it is under federal control, industry will never become involved in the operational aspects of the program--or any aspects for that matter. The major factor controlling industry involvement is the element of financial risk. By not designating the Landsat MSS system operational seven years ago (thus defining the proven and low-risk technology) and by creating a federal maze of agency infrastructure and regulation, the government has increased the risk so that industry has taken a "wait-and-see" attitude. The fact is industry involvement in the operational aspects of a federal program will naturally occur in our society, if encouraged, by making it highly desirable from both a government agency and private sector perspective. What we have done to date is to move in exactly the opposite direction.

Another myth is that technology becomes frozen when a system is designated operational. Even though the performance of the MSS has surpassed all expectations, its design is based on 15-year old optical-mechanical scanning technology. If the government had designated the Landsat MSS operational in 1975, we would probably be flying a calibrated, solid state, linear array instrument based on the MSS, on Landsat-D. Industry would have probably been a major participant in the development of this improved technology.

A third myth is that when the program becomes completely operational, government should hand it entirely to industry. Again, it should be stressed that the key to industry involvement is the element of financial risk. Government should conduct fundamental research in technological development which has a high element of risk, which requires a longer term investment, and which has a high potential for application. The government should also test the new technology and methodology, perhaps in concert with users, as it has done so successfully in the joint NASA-GEOSAT test cast project. Then if the developed technology is proven to be low-risk, industry will use that technology in the operational aspects of the program.

For example, the mineral and petroleum industries are anticipating analyzing experimental data from the thematic mapper (TM) sensor on Landsat-D because of the promise TM simulator data have shown for geological mapping and the delineation of areas of potential mineralization. NASA will have to analyze the initial data from the TM to determine the proper sensor calibration and imaging geometry. We, in industry, will have to experiment with Landsat TM data to learn what geological information can be extracted from such data acquired from satellite altitudes. Once TM sensor performance is fully understood and the potential applications are known, then it seems reasonable that the TM should also be designated as an operational sensor along with the MSS. Subsequently, the aerospace remote sensing industry will become involved in operational aspects of the TM systems. It is logical to expect that industry eventually will want to employ a solid state linear array sensor based on the characteristics of the TM, but one which employs proven low-risk technology. This latter development in the operational program will be possible only when the government completes the high-risk technological development of linear array focal plane technology in the short wave infra-red (that portion of the spectrum which ranges from 1.0 to 2.5 micrometers in wavelength).

What I am stressing is that technology and science will continue to evolve, bringing forth new ideas, methods and instruments; therefore, to freeze the program by handing it completely to industry is not sensible at any time in the near future.

Another myth is that because NASA's Charter focuses the efforts of that agency on research and technology development, NASA should not be involved in the operational aspects of the civil remote sensing program. Such an assumption is absurd because NASA is currently involved in the largest segment of the Landsat program. It is "the" agency which is conducting the major portion of the fundamental research and technology development in land remote sensing, and it has a proven track record in working with the aerospace and value-added remote sensing industries. To add other elements of the federal bureaucracy to the civil land remote sensing program will not only increase proliferation of government and lead to increased government spending, but will discourage industrial involvement in the program. If NASA's Charter does not provide for management of the operational aspect of remote sensing from space, then change the Charter. After all, that Charter was written 20 years ago and at that time we had just entered the satellite age. The government should be moving toward designating a single federal agency for civil land remote sensing, not growing from two agencies to three.

Lastly, another myth that seems to cloud the issue of moving civil land remote sensing to an operational status is that comprehensive legislation and policy are required to cover all aspects of operational activities. I arrived at this conclusion from examination of your rather imposing list of issues that "should be considered in establishing an Operational Land Remote Sensing System".

Quite frankly, there are many very intelligent people in both industry and government who can work out the details once the government makes the committment to operationalize civil land remote sensing. It is my personal belief that the legislation should be kept as simple and as broad as possible to ensure its rapid passage through Congress and, thus, correct past errors. The legislation must establish a level of funding to support immediate up-grading of the present system from an experimental to an operational status. In the near term, this means operationalizing the distribution of MSS data, and after the TM is tested, data systems as well.

Let me now turn to an area that deeply concerns the mineral and petroleum industries. That is the area of developing and testing new advanced technology. Since 1976 the scope of international development in satellite remote sensing has changed dramatically. Foreign countries are aggressively copying our existing systems as well as developing new ones which will employ the latest advanced solid state and microwave imaging technology. Since 1976 NASA has proposed a series of new experiments to develop and test new advanced technology for global resource investigation. Some of this advanced technology includes multispectral linear array sensors, linear array stereoscopic sensors (such as a solid state stereo-capability satellite), advanced mircowave imaging systems, and potential field mapping satellites such as Gravsat. The mineral and petroleum exploration industries urgently need the data furnished by this technology to find the resources we need for the future. (See my paper, attached to this testimony, delivered at a recent conference in Washington, D.C., June 9, 1981.)

It is my understanding that since 1976 NASA has not been successful in obtaining funding for these technological developments. During the same time foreign countries have moved aggressively forward in these areas and are planning to launch major new systems for their resource industries by the middle of this decade. If the United States does not move forward to obtain its own data, U.S. industries will be forced to purchase these data from foreign sources. Development and testing of our own technology has been postponed out of concern that through time the technology may become less experimental and more operational, but that is exactly what should happen if we are to maintain our technological advantage in the applications of aerospace techniques to global resource problems.

NASA's role in aerospace remote sensing has always been to conduct the necessary longer term, high-risk (but potentially high pay-off) research and technological development for experimental prototype systems. In the last 6 years that role has been overlooked because of the attention focused on formulating the operational aspects and industry involvement in civil land remote sensing.

With the success of the space shuttle the United States has a unique tehchnological opportunity in this decade to test new concepts and hardware in space at a fraction of the cost associated with the use of free-flying experimental satellites. Yet, NASA programs related to instrument development and testing of earth observation payloads in the shuttle are almost non-existent for lack of funds. This nation now has a major technological breakthrough. An opportunity of this magnitude may come about only once or twice in a century and we are failing to exploit it.

There is an immediate and critical need to correct this incredible oversight if the United States is to remain competitive in aerospace remote sensing and in the applications of remote sensing techniques and data to our own, as well as global, resource problems.

In summary, I am recommending the following: (1) There is a critical need to adequately fund longer term, high-risk, but potentially high pay-off fundamental remote sensing research and technology development within the government to capitalize on the tremendous technological advantage that the space shuttle provides; (2) The Landsat system should be declared operational and we should recognize that technology changes in the operational system would occur when proven, low-risk technology is available. Therefore, a level of funding must be established to support that operational status; (3) The single federal agency responsible for land remote sensing and the remote sensing industry should together work out the details regarding the best institutional framework and legal arrangements to ensure maximum industry involvement in the program; (4) The government should be responsible for the high-risk elements of the operational program. This is the state of most of the program now, but the government's share will decrease as technology advances and industry becomes more involved in the operational aspects of the program; (5) Industry participation should be encouraged to the highest degree possible by (a) legislation as broad and simple as possible to permit future industry involvement in all types and phases of civil remote sensing activities, and (b) the government bureaucracy should be streamlined so there is a single government agency interface - - and I recommend that this agency be NASA; and (6) I want to make it perfectly clear that I consider myself as one of this nation's strongest advocates of the free enterprise system and, sooner or later, I would like to see industry take over as much of the civil remote sensing program as possible, including ownership and operation, PROVIDED there are no guarantees or subsidies from the government, and also that any industry involvement will be consistent with the international policies of the United States. (7) It is imperative that the United States launch as soon as possible a solid state stero capability satellite from which its data would tremendously aid in discovering the energy and mineral resources which are so vital to this Nation as well as to the rest of the world.

In closing, let me say that I believe the Landsat project is the most significant mission ever flown by NASA. The use of Landsat imagery by the mineral and petroleum industries in the United States can improve the nation's domestic resource base in a shorter time and at a more reasonable cost than would be possible otherwise. Therefore, our civil remote sensing program is a national asset and conferring operational status on that program is going to profoundly improve the development of American civilization.

As users of remote sensing data, the mineral and petroleum industries need such data provided on a continuous basis over periods of years in standardized formats that are optimal for our use and at reasonable cost. This is what the establishment of operational civil land remote sensing means to us. It also means that, in return, the people of our country will be provided the resources they need in a more efficient manner. It means growth of the aerospace industry and value-added industries and, even more significantly, it is a first step toward the development of a new industry of information technology which will rival that of the communications industry. Now is the time for us to recognize this long overdue opportunity and get on with the business of operational land remote sensing.

Thank you, Mr. Chairman and members of the Subcommittees, for this opportunity to talk to you today.

ANSWERS TO SENATE QUESTIONS SPECIFICALLY FOR DR. MICHEL T. HALBOUTY—PAGE 1

1. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

   ANSWER: The United States should maintain the "Open Skys" policy that allows any government, group or individual to purchase data, acquired with government systems developed by this country, over any portion of the Earth's surface. However, the United States should not distribute the data in a manner which would allow it to be used for aggressive military operations against other countries. Secondly, if the remote sensing industry is to be involved in the distribution of operational data, that industry should be allowed to offer special services in data processing, including rapid dissemination to users or investors who pay surcharges for such services. EDC currently imposes a surcharge for rapid processing of Landsat data.

2. The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

   ANSWER: Major cost reductions must occur as portions of the Landsat system are declared operational, thereby identifying the low-risk technological requirements. The MSS portion of the Landsat system should have been declared operational in 1975, when it operated to specifications on Landsat-2. Instead, in order to provide continuous MSS data NASA had to add a thermal band (which did not work) to the Landsat-3 MSS and had to completely redesign it for a lower altitude on Landsat-D. Initially, the MSS system will have to be upgraded from experimental to operational, but once that investment is made, costs should decline as more efficient processing technology is employed by industry.

3. Are you aware of aggressive marketing by the French for SPOT data?

   ANSWER: Yes. The French have a worldwide marketing effort underway for SPOT data. They have approached the U.S. minerals and petroleum industry individually and through the GEOSAT Committee. They have offered to completely subsidize the "International Symposium on Remote Sensing of the Environment," managed by ERIM, in 1984. According to ERIM personnel, the French have specified that the Symposium must be held in Paris after the launch of SPOT and no other conferences can be held by ERIM that year. The French will also control the program and exhibits at that conference.

Answers to questions specifically for Dr. Michel T. Halbouty - Page 2

4. What are your views on single entity operation of the system versus competition for the various segments of the system?

ANSWER: Single entity operation of the system is only possible if the government is the single entity. Industry cannot take over the entire "system" because elements of the system are still in an experimental stage, and the system should always be evolving so that experimental sensors are always being tested by the government. If you are referring to the single entity operation of the entire land and meteorological observing system that has been proposed informally by COMSAT, I am against this approach. COMSAT is asking for the meteorological satellite program, along with the land observing program, because it knows the government will subsidize the high-technological and market risk associated with the entire land observing program. There is little question that establishment of a single private industry entity, to manage all aspects of land and meteorological remote sensing, will establish a monopoly. If the government is the major user of the monopoly services, then it is a government subsidized monopoly. Our democracy is founded on the principles of free enterprise and competition is the heart of our capitalistic system. The more industrial participation in the national remote sensing program, the greater our gross national product will be and ultimately the stronger our economy. Government subsidies to industry should be avoided at all cost. A government subsidized monopoly is a socialistic evil - - competition for the various elements of the program should be encouraged to the highest degree possible.

5. We have heard from a number of people that guarantees or subsidies would be required for some time, yet you say you would like to see industry ownership and operation provided there are no guarantees and subsidies. In what ways does your scenario differ from others that we have heard from? What time frame are you thinking about?

ANSWER: There is no requirement for any subsidies or guarantees if the government establishes the performance requirements for MSS data dissemination to users. Designation of the MSS as operational defines the low-risk technology needed to deliver data in an operational manner. This should be done now. Industry should naturally want to participate in the low-risk portions of the program if such participation is not discouraged through unnecessary regulation and taxation. The government should continue to conduct the necessary high-risk technological research, but should not subsidize the low-risk portions of the program if industry is involved. Either industry comes forward and agrees to manage the MSS

5. (continued)
system, and introduces new state-of-the-art technology to bring the costs for MSS data down, without any government guarantees or subsidies, or the government continues to operate the MSS because availability of its data is in the "national interest." There can be no middle ground in this issue. The main difference between what I am proposing and the proposals from others is that they assume that the entire system must be handed off to industry. If that were the case then the government would have to subsidize the high-technological risk elements of the program. What I am saying is that the government should continue to participate in the development of the high-risk technology, and when this technology is proven to be low-risk, industry should naturally want to use this technology in land remote sensing. The fact that the government performs the high-risk technological development is not a subsidy, it is an activity that is appropriate in our society because it is a service that government provides in return for the taxes industry and private citizens pay, and it ultimately stimulates the growth and development of the American economy.

6. What is your view on the policy of non-discriminatory distribution of data?

ANSWER: This question is covered in the answer to question 1.

7. You suggest that NOAA draft legislation, if enacted, would have ensured little private sector interest. Could you be more specific on what provisions of this draft legislation inhibit private sector involvement?

ANSWER: The Department of Commerce (DOC) draft legislation entitled "Land Remote Sensing from Space Act of 1981" is filled with legal regulatory jargon which places such constraints on normal business practices that it would doom private ventures for decades. In particular, the sections on conflict of interest between applicants, users, value added industry, and potential equipment suppliers have a strong anti-trust flavor which would discourage the very elements which should naturally come together in a private sector program. The sections that state that our industry must work together with other countries or groups of countries toward achieving complementary systems, suppress healthy competition. The section which submits the applicant and his proposal to review by Justice, State, Defense, CIA, Commerce, Officials of State and Local Government and interested persons, with probable selection by OMB (as the agent for the Executive Office) and, at the lowest possible cost to the government, will ensure that decades will pass during the review and appeal process. After all this,

7. (continued)

there is the section that states that there is nothing to preclude the government to develop its own civil remote sensing systems and compete with industry and the government will be able to fix prices industry will charge as it deems necessary. The sections on informing the government on all foreign business dealings, giving the government full access to all records discourage private sector interest through unnecessary regulation. The entire document has a punitive tone, especially the sections on supervision of the applicant, sanctions, judicial review, enforcement, fines, injunctions, and non-performance. These sections are written as if the government expects industry to fail and then will hand out punishment. In one section, there is the statement that anyone will be able to bring suit to the industrial operator regardless of the magnitude of the problem. This could potentially bury the courts in trivial suits.

As I have said before, NASA and industry should work out these details. The legislation should be kept as simple and broad as possible to ensure its rapid passage through Congress. Industry should participate in drafting the legislation.

ANSWERS TO HOUSE QUESTIONS FOR LAND REMOTE SENSING REPORT BY DR. MICHEL T. HALBOUTY—PAGE 1

1. The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.

(a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

ANSWER: (a) Geologists anticipate the development of solid-state linear and/or area array imaging spectrometers with an onboard signal processing capability to permit selection and combination of data from tens of wavelength bands. This should allow a wide variety of users, from agriculture, forestry, landuse fields as well as the geosciences to select coverage of specific sites at high resolutions. Such high resolutions might include spatial resolutions of 10 meters or smaller over 100 km swath widths with spectral resolution in as much as 100 or more wavelength bands at bandwidths of 0.01 um or less. At these resolutions, global repetitive coverage is out of the question so geologists, and probably scientists from other disciplines will require continuing global repetitive coverage from a low-resolution sensor like the MSS, to evaluate changing landscape conditions and select sites and times of year for high resolution coverage. High resolution (10 to 15m GIFOV) stereoscopic data could be acquired from the same platform, and perhaps sensor, with a pointing capability.

Geologists require repetitive thermal data (8 to 14 um) at 100 meters or better GIFOV on a diurnal basis to evaluate heat capacity, density and thermal conductivity (thermal inertia) of geologic materials. Recent research indicates that such thermal measurements should be made in a number of wavelength bands to evaluate the spectral emissivity of rocks and soils which is known to be related to their mineralogic composition (particularly silica and carbonate content). Users in agriculture and forestry have yet to fully exploit this portion of the spectrum, however, thermal inertia has proved useful for analysis of soil moisture. A thermal mapping satellite will require data acquisition times of 1:30 p.m. and 1:30 a.m. local time, and therefore, its orbital configuration not compatible with that of a platform which acquires high resolution data in the visible and near infrared.

Answers to questions for Land Remote Sensing Report by Dr. Michel T. Halbouty - Page 2

Geologists also want repetitive imaging radar data at two, if not three frequencies, with dual polarizations, and multiple imaging geometries. Such data is desired at 25 meter or smaller GIFOV, over 100 km swath widths, for specific sites. Multiple imaging geometries will allow terrain to be analyzed stereoscopically. Radar look directions (azimuths at which microwave radiation is propagated toward the earth's surface) should be arranged to illuminate the earth's surface not quite orthogonally, and at angles not illuminated commonly by the sun. Users in other disciplines like agriculture and hydrology may want diurnal coverage, or coverage with radar every three or four days. Such requirements dictate orbital configurations different from visible and near infrared sensors, but perhaps compatible with thermal infrared sensors.

Geologists strongly rely on the synergism of combined analysis of visible, infrared, and microwave data to maximize information extraction. Therefore, it is vital that standardized procedures be employed to calibrate sensors, in preprocessing to apply radiometric and geometric corrections, and to produce data in standardized scales, accuracies and formats. Such standards should minimize the problems of multiple data set registration. The government should establish and maintain such standards because several industrial concerns should be involved in operational remote sensing systems and the government will be operating experimental systems as well. Secondly, it is vital that data acquired by U.S. remote sensing systems, over foreign territories, be made immediately and directly available from U.S. sources to U.S. users, especially our industry. This is not the case with Landsat data, and our own industry must deal with a nightmare of foreign receiving facilities which all produce data in different formats and discriminate against U.S. companies in delivery time. With the tracking and Data Relay Satellite System (TDRSS) to be employed with Landsat-D, data will be transmitted to the United States when it is acquired over foreign territories although foreign receiving stations will receive it directly as well. U.S. citizens, U.S. industry and U.S. government agencies should have direct access to that data in the U.S. and they should not have to deal with foreign countries.

(b) It is doubtful that weather satellites could be effectively combined with land remote sensing satellites in an effective system. Weather satellites must provide data almost continuously and thus should be in geosynchronous orbit. The level of true applications maturity of the weather program is quite low. To further amplify, the pictures the average citizen sees on television of weather patterns in no way justifies the enormous expenditure to obtain them. The true utility of the pictures is in fundamental research, and at this stage, they still do not even satisfactorily supplement the synthesis ground-based point measurements into a weather map. Much scientific research of a long-term nature will have to be done before weather satellite data can be used for its intended purpose - weather prediction and climatic change monitoring. Observations of weather require very coarse resolution (1-10 km IFOV) when compared to land observing systems. Land observing systems need to orbit the earth in near polar, low altitude (less than 1000 km) orbits to maximize ground resolution. There is no need to combine the weather satellite program with the communications satellite program. The weather satellite program is a high-risk, long-term scientific research program in which the government is the major benefactor. The communications satellite program is a highly applied program managed by industry with the private citizen and private industry as the major benefactors. To mix these two programs makes no sense whatsoever, and it cannot result in any economy.

2. Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of Landsat system and whether the system should be operational now.

(a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

(b) What is the applicability of Landsat-D to an operational system?

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

ANSWER:

(a) Yes, the MSS should have been declared operational when Landsat-2 achieved orbit and the sensor operated to specifications in 1975.

(b) The MSS should be designated as operational now and its data handling system upgraded from experimental to provide data on an operational basis. The Thematic Mapper will remain experimental until NASA thoroughly calibrates its data and develops procedures for proper geometric display of TM data. Once TM data are thoroughly understood by NASA and users then probably when Landsat-D'is launched the TM system should also be designated as operational and be upgraded to provide data on an operational basis.

(c) Absolutely not! The present program is in a shambles. It is split between three agencies and all three are underfunded to correct the problems with data delivery. That is, to deliver at least MSS data in an operational manner. NASA should be designated the sole government agency for civil land remote sensing and NASA should work directly with industry in defining industries role in the operational aspects of the program. The government must oversee land remote sensing because it is a national asset. The government must conduct the high-risk, longer-term, but potentially high payoff aerospace remote sensing research and must ensure that the required data are delivered to users in standardized scales, accuracies and formats, and in a timely manner. By so doing, the government is providing a guarantee to users of the data, but it is not providing any guarantees or subsidies to industry to participate in the program.

3. Policy issues relating to the proper government/private sector relationships and the scope of involvement of the commercial sector are in need of further clarification.

(a) By what process should responsibility for remote sensing move to the private sector?

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the question of finances)?

(c) Is a monopoly necessary for private sector operation of a Civil Land Remote sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

(d) How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

(e) Is a copyright provision necessary for private sector operations?

(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

(g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

(h) How should a private sector operator be regulated, if at all?

(i) Who should do R&D? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

(j) How should the sale price for government equipment be determined for a transfer to the private sector?

(k) If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

(i) With respect to continuity?
(ii) With respect to technical development?
(iii) With respect to market preparation?

(l) What would joint ventures between government and businesses contribute to the present system? Is legislation necessary to permit joint ventures?

ANSWER:

(a) PD-54 should be immediately rescinded and NOAA should be removed from the program. Management of the government aspects of the program should be placed under NASA and this includes the EROS Data Center operation. The MSS system should be immediately declared operational and upgraded to provide data on an operational basis. NASA should entertain proposals from industry on the upgrade and operation of the MSS data processing and distribution system. When the TM is successfully tested on Landsat-D, NASA should entertain proposals from industry to upgrade the TM from an experimental basis to provide TM data an operational basis. Industry and NASA should work together in the future to define high-risk, longer-term, but potentially high-payoff research to be conducted by NASA and low-risk elements of more proven technology to be developed by industry.

(b) Yes. If the private sector were responsible for operational delivery of MSS data to users, then it will want to control MSS data acquisition to eliminate unwanted data. However, in the Landsat-D time frame, it may not be necessary for industry to control the platform, particularly if the government is testing other sensors on that platform. Government should encourage industry to manage as many of the segments of the land observing system as industry is willing to operate, but the government should recognize that industry may not want to manage high-risk technological elements and that it will be in the national interest for the government to support these elements.

(c) A monopoly is not necessary for private sector participation in a Civil Land Remote Sensing System. Monopolies should be avoided because they do not fully stimulate growth and development of the gross national product.

(d) There should be no guaranteed government business or subsidies to the private sector for operating low-risk elements of the operational system. There is no question that government subsidies diminish healthy competition and inhibit innovation.

(e) A copyright provision is required for private sector operations.

(f) Non-discriminatory data access is compatible with private sector involvement. Anyone, any group, or agency should be able to buy the data. Special data services, such as rapid delivery, should be provided to investors or to those who are willing to pay extra for them, but ultimately data should be available to all users especially if it is acquired over foreign territories and U.S. government equipment or facilities are in some way involved in data acquisition. Data should not be distributed in a manner which will support aggression against third parties.

(g) If an independent U.S. based company funds, develops, launches, and acquires data over U.S. territory with its own system, and uses no government equipment then that data could be proprietary if the company desires it to be. There are lots of precedents for this. If an independent U.S. based company acquires data over foreign territory using its own equipment and uses the data for its own purposes then the data could be proprietary. However, if the U.S. based company sells data acquired over foreign territories to other companies, individuals or foreign governments then the company should abide by the international policies of the United States Government - - that is, data distribution should be non-discriminatory and consistent with the "Open Skys" policy. Congress should avoid legislating these issues, they should be handled on a case-by-case basis because each case is different.

(h) Regulation of the private sector should insure that data is provided in standard scales, accuracies, and formats. The government should also ensure that there is no overlap in data transmission links and that international policies, where appropriate, are adhered to.

(i) NASA should do the longer-term, high-risk, potentially high payoff research and development. Please refer to my testimony.

(j) Government equipment should be depreciated. Actually there is little government equipment industry will want because it is experimental and is so out of date. Why is Congress concerned with this? NASA and industry can work out these details - - you can't write legislation to cover all the different cases!

(k) If the private sector is to be involved in the operational aspects of civil remote sensing initially the government will have to operate the space segment insofar as the platform and TM sensor is concerned. Industry will want to control MSS data acquisition and thus may want to control that portion of the space segment. Therefore, with Landsat-D industry and government would share in operation of the space segment and with Landsat-D' industry might control both the MSS and TM if the TM is designated as operational. However, those instruments will be launched by NASA and will be carried on a NASA Multimission Spacecraft bus and NASA could retain operational control of the platform. Should industry come forward with a platform and sensors to be launched by Shuttle, industry could pay for Shuttle services and insertion into the correct orbit and then truly operate space and ground segments in the beyond Landsat-D' time frame. Technical development of the low-risk technological elements of the program would clearly rest with industry as would the aspects of market preparation.

(l) Joint ventures between industry and government are the only way to get industry involved in the near term. Currently NASA has difficulty in consumating joint ventures with industry because by law NASA cannot commit to funding beyond the coming approved fiscal year.

4. Universities are currently involved in research and training in the area of remote sensing.

   (a) How is the contribution of universities important?

   (b) What should be the role of universities in the future, i.e., if we have an operational system? What should be the role of the Federal government vis-a-vis universities?

   (c) How would commercialization affect the universities? What are the dangers of benefits of commercialization for universities?

ANSWER:

(a) They are capable of performing research of a more applied nature which expands fundamental research done by the government to define potential applications, into research to demonstrate the application of remote sensing techniques to particular problems, like resource assessment or continental geology.

(b) The university role will not change for an operational system. The Federal government will continue to fund university research to evaluate data from experimental systems. If anything, the university role will expand because industry will most likely want to use universities for research in the operational aspects of the program.

(c) Commercialization will have a positive affect on the universities because more funding for research will be available and university students will have expanded opportunities for employment.

5. Satellite data is being utilized to provide data for public services.

   (a) How is the utilization of remote sensing data important to the public welfare and health?

   (b) To what extent are State and local governments utilizing this data for public services?

   (c) What are the primary concerns of the state governments (i) with the system as it would be if Landsat-D (and then D') were run by NOAA as they are now running Landsat-2 and 3? (ii) with the future commercialization of land remote sensing?

ANSWER:

(a) Currently, Landsat MSS data are being routinely utilized to monitor land use change and environmental conditions.

(b) State and local governments are now developing data banks based on Landsat MSS data and they, in time, may become the major repetitive users of MSS for monitoring land use change and changes in environmental conditions.

(c) State governments want data in standardized scales, accuracies and formats. They want a guarantee, before they fully commit to spaceborne remote sensing data, that the data will be readily available, on a continuous basis for tens of years, at reasonable costs. NOAA is not running Landsat 2 and 3, NASA is and the system is still experimental. Therefore, state government is unwilling to fully commit to the use of Landsat data, as long as the data system is experimental. State government will be concerned that commercialization will lead to higher costs for data. However, if the government operationalizes the MSS, and if industry involvement produces greater data distribution efficiency, state and local governments will still be willing to pay increased prices for better services.

6. There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop.

(a) Is present data receipt and handling centralized? What are the advantages and disadvantages?

(b) Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt handling? If this is possible, what are the possible benefits and disadvantages?

ANSWER:

(a and b) There is no effective way to legislate the most effective method of data distribution. That will evolve as a function of technology, market (user needs), national interest, and the balance between government and industrial programs. Again, NASA and industry should work out these details.

7. There is a need to clarify how remote sensing data could or should be priced.

(a) For a government-operated system, should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

(b) If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

ANSWER:

There is no need in the legislation to clarify how remote sensing should be priced.

(a and b) The government should recover its costs for reproduction of experimental data and all users should be charged equally. Recovered costs should not include any costs for the experimental system, equipment required to reproduce the data, etc. Reproduction costs should be related directly to time and material. There is no need for the government to provide any "value-added" special processing services. The government should only reproduce duplicates of master archival film and CCTs.

(c) The government should definitely not prescribe guidelines or promulgate any regulations concerning pricing of data produced by industry.

8. The following questions do not have to be considered Landsat specific, but can be viewed as pertaining to remote sensing from space in general.

(a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

(b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Answers to questions for Land Remote Sensing Report by Dr. Michel T. Halbouty - Page 11

ANSWER:

(a) The potential value and importance of remote sensing from space have been largely ignored by previous Administrations and decisions related to our civil land remote sensing policy have suffered from unwise budgetary control and executive branch inaction which have focused on saving money without due regard to the national interest. Under the circumstances, NASA and the Department of Interior have done an outstanding job in trying to develop a national remote sensing program and the problem does not rest with them. The problem rests with the executive office, specifically with OMB, which without presidential direction, has discouraged the full development of civil land remote sensing, to the point that foreign countries are now developing most of the new technology in this decade. By and large, Congress has been supportive of the domestic remote sensing program, but the program needs legislative mandate to move forward now.

(b) Government policy (PD-54?) did set a stage for a move to an operational system, but in the wrong direction. NOAA was established under PD-54 as the agency responsible for civil remote sensing. NOAA lacked the internal expertise to come up with a good plan for moving to an operational system and they produced draft legislation which would have totally discouraged industrial involvement in civil land remote sensing. PD-54 should be rescinded and NASA should be given total responsibility of working out arrangements with industry. All government civil land remote sensing activities should be managed by NASA. The Landsat MSS system should be designated as operational now and should be immediately upgraded to provide MSS data to users in an operational manner. Industry should be encouraged to participate in the upgrading of the MSS system. By designating the MSS operational, the government will be guaranteeing users a level of performance with respect to MSS data. This is not a guarantee or subsidy to industry. If industry does not come forward with acceptable proposals for participation in the operational aspects of Landsat MSS data distribution, (that is proposals which do not rely on guarantees or subsidies) then the government will have to continue to provide MSS data because it is in the national interest to do so. I believe, however, that if the government designates the Landsat MSS as operational, and thereby identifies the low-risk technological requirements, that the aerospace and value-added remote sensing industries will come forward with good proposals to provide MSS data on an operational basis.

Mr. FLIPPO. Dr. Halbouty, thank you very much for the stimulating testimony.

Mr. Rosenberg?

STATEMENT OF A. J. ROSENBERG, VICE PRESIDENT, GENERAL ELECTRIC CO., AND GENERAL MANAGER, SPACE SYSTEMS DIVISION

Mr. ROSENBERG. Mr. Chairman, I welcome this opportunity to offer some observations about the state of the civil land remote sensing program, particularly before these two congressional bodies which have done so much to make Landsat a national asset of global dimension and significance. Most of us are familiar with the capability and versatility it has demonstrated, whether in developing technology for accurate forecasts of the Russian wheat crop, mineral surveys, hydrology, land use planning, and other beneficial applications. But we are here today because its greatest potential is yet to be realized. We are all custodians of a long-range investment which can yield immense dividends to the Nation through wise and patient management.

General Electric is deeply committed to the future of this program, having been its advocate from the beginning as a working partner with NASA and other groups, public and private. We have participated in all phases of its development, operation, and application, totaling more than 12 years of hands-on, day-to-day involvement, and have a vital interest in its futher growth and progress.

There are two critical issues: First, about whether the system technology is now ready to move to operational status; and second, whether the program is now ready for ownership and operation by the private sector.

With the launch of Landsat-D in the summer of 1982, the space segment will be ready to support operational applications. The ground segment's capability has already been proved experimentally, and we have high confidence that it will support an operational system successfully.

There are many users of data all over the world who have learned to use the data productively, and more who are developing this capability. But even more have been hesitant to make the capital investment required for information extraction equipment and personnel training, at least partially because they lack assurance that the data will continue to flow without interruption over the foreseeable future of their missions. Obtaining the commitment of a large enough body of these users may be the most important step in transition of the system. And data continuity is the key as members of the user community have testified already.

Our concern over data continuity should not be limited to its impact on the user community alone. How can entrepreneurs be expected to invest in any enterprise unless they are certain that it will be sustained through the initial period of market development? It should be clear that any mandate for either commercial ownership or operational status could be self-defeating if it does not include assurances for data continuity.

The threat to continuity is real. The present transition plan assumes perfect launches and perfect onorbit performance from two consecutive space vehicles through 1988. I question the wisdom of risking the future of the program on an assumption that Landsat-D and D prime will be free from accident and anomaly. Any one of a number of unpredictable occurrences, such as launch failure, sensor malfunction, or a break in the data link, could interrupt or degrade the flow of data.

Only one organization in my opinion can assure data continuity—the U.S. Government. I believe the Government should provide the system with this continuity by procuring spare satellites and specifying early launch readiness so that an uninterrupted flow of data is available. This action should begin with provision for long-lead item procurement in the fiscal year 1983 budget. Unless such action is taken, all our discussion about how to manage the future of the program may become academic.

Once continuity is assured, the other central issues, such as the feasibility of operating the system as a commercial venture, can be addressed more confidently. This process will also require long periods of time, and the Government's continuity planning must assume that a protracted transition period must be supported to do a valid assessment.

From a business perspective, I have examined carefully the concept of commercial operation, and I have serious concerns and doubts. Through NASA's R. & D. programs, Landsat has developed a wide diversity of applications, and demonstrated that the system can deliver immense value to the national economy. Many organizations all over the world have bought and used data. Nevertheless, few organizations have adapted the data for regular routine use in their missions. And thus, few can assign a dollars-and-cents value to it on a day-to-day basis. Consequently, I share the concern that was expressed by Mr. Beggs yesterday as to whether these users constitute a base market upon which to build a business. I haven't seen any meaningful market figures which would convince me that they do.

There are uncertainties about the level of service that such a market can support, and this raises questions about cost levels, capital requirements, and other vital business factors.

Among those uncertainties must be included that of capital requirements necessary for onorbit spare satellites to maintain the data continuity which we have identified as a necessity for any viable system. How would an entrepreneur finance this hardware, and how would he get a fair return on a sizable risk on his investment?

I am convinced that a land remote sensing system can produce benefits to the Nation which are measured in hundreds of millions of dollars or even more. As was mentioned earlier this morning, if an operational system had been in place at the time of the Russian wheat deal, data about the Russian crop failure could have produced sizable financial benefits to American farmers, food processors, commodity brokers, and, ultimately, the taxpayer. The U.S. Government, as the dominant user of the data and dispenser of its benefits, could have provided the country with a significant public service. If, on the other hand, a private entrepreneur had been operating the system at that time, he might have wanted to receive revenues proportionate to the value of the service he performed, but he would have had no way of collecting them.

In the majority of cases, benefits from the Landsat system can yield significant monetary value only by distribution through governments. Free market forces could not create revenues under such conditions, and government would therefore have to provide them.

Another impediment to free market operation may be the problems that a private venture would have in competing with foreign competitors backed by their governments. To build and maintain a world market could be difficult or even impossible because of the financial advantage such foreign competition would have.

So, both to maintain the public service functions for the American taxpayer and to sustain a competitive position internationally, substantial subsidies from the Government might be necessary as cited by Mr. Beggs in yesterday's session. But present policy, with which, incidentally, I am in full agreement, is that such subsidies should not be paid. And without them, there is a very sketchy, and obviously inadequate guarantee of a large enough market to sustain a private enterprise.

Aside from its purely financial aspects, the market issue raises additional institutional and procedural questions. I am not sure, for example, that adequate means are available today to identify, measure, and develop the remote sensing market with its broad spectrum of real and potential users. Since the Government is now the market for about half of the data, its future role and responsibility in providing a continued market is a real concern.

Such issues are large and concrete, while the data base available to resolve them is small and speculative. Given the size of the identifiable market, the large front-end costs, and the prospect of many years of investment before any recovery can be expected, I have serious doubts that most businessmen would choose to enter land remote sensing as a total commercial venture today, or, if they would, that they would be successful financially.

Nevertheless, we can expect continued pressure to recast the system into some kind of commercial enterprise. And I think we should ask ourselves whether pressure alone can suddenly produce answers to questions that have challenged our most knowledgeable and experienced people for virtually the entire life of the program. To rush precipitously into any mode of system transition before this formidable array of issues has been resolved is to jeopardize the investment of the Government and the interests of the user community.

It has taken 9 years of experimental effort to establish the utility of Landsat. The system represents a billion dollar investment. Prudence and good business judgment dictate that we think of our payoff on a long-term basis. If the future of the system includes commercial operation or ownership, the provision of data continuity, and a systematic approach to market aggregation, will be necessary and valuable preparations for the transition. In my view, these preparations will take many years and much dedicated effort.

At this stage, the primary concern should be to preserve the integrity of the system we have and protect our national investment. These two subcommittees have always shown commendable initiative in advancing the interest of the program. And I hope that the suggestions I have made today will be of value in the continuation of that initiative and interest.

Thank you.

[The complete prepared statement, plus answers to questions asked of Mr. Rosenberg follow:]

TESTIMONY BY

ALLAN J. ROSENBERG
VICE PRESIDENT, GENERAL ELECTRIC COMPANY
GENERAL MANAGER, SPACE SYSTEMS DIVISION

before

THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
U.S. HOUSE OF REPRESENTATIVES

and

THE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE
U.S. SENATE

on

CIVIL LAND REMOTE SENSING SYSTEMS

on

THURSDAY, JULY 23, 1981
WASHINGTON, D.C.

Introduction

I welcome this opportunity to offer some observations about the state of the civil land remote sensing program, and I am particularly pleased to do so before the two Congressional bodies which have done so much to make Landsat a national asset of global dimension and significance.

Most of us are familiar with the capability and versatility it has demonstrated, whether in developing technology for accurate forecasts of the Russian wheat crop, or locating a productive oil field in Wyoming, or functioning as a key decision-making tool in large-scale regional water empoundment and irrigation projects, or in accurate mapping of public lands over entire states--even over Alaska's millions of acres. But I believe we are here today because its greatest potential is yet to be realized, with the improved 30-meter resolution, seven-band spectral coverage, and 48-hour data turnaround time of Landsat-D. We are all custodians of a long-range investment which can yield immense dividends to the nation through wise and patient management.

GE's Posture

GE is deeply committed to the future of this program, having been its advocate from the beginning as a working partner with NASA and other groups, public and private. We have participated in all phases of its development, operation and application totaling more than twelve years of hands-on, day-to-day involvement, and have a vital interest in its further growth and progress. Thus, we are seriously concerned about the proposed plans for the program's transition.

System Readiness

Any examination raises the critical issues covered in your letter of invitation: first, about whether the system technology is now ready to move to operational status; and second, whether the program is now ready for ownership and operation by the private sector.

With the launch of Landsat-D in the summer of 1982, the space segment will be ready to support operational applications. The ground segment's capability has already been proved experimentally, and we have high confidence that it will also meet operational requirements.

There are many users of data all over the world who have learned to use the data productively, and more who are developing this capability. However, even more have been hesitant to make the capital investment required for information extraction equipment and personnel training, since they are not fully convinced of its utility, and since they lack assurance that the data will continue to flow without interruption over the foreseeable future of their missions. Obtaining the commitment of a large enough body of these users may be the most important step in transition of the system to any future state, and data continuity is the key.

The Continuity Issue

Our concern over data continuity should not be limited to its impact on the user community. How can entrepreneurs be expected to invest in any enterprise unless they are certain that it will be sustained through the initial period of market development? Can this nation retain its leadership if data gaps make it vulnerable to inroads from foreign competitors? Such questions make it clear that any mandate for either commercial ownership or operational status could be self-defeating if it does not include assurances for data continuity.

And the threat to continuity is real. The present transition plan assumes perfect launches and perfect on-orbit performance from two consecutive space vehicles through 1988. While Landsats 1, 2, and 3 have already yielded a total of 13 years of successful on-orbit operation, I question the wisdom of risking the future of the program on an assumption that Landsat-D and D1 will also be free from accident and anomaly. Any one of a number of unpredictable occurrences, such as a launch failure, sensor malfunction, or break in the data link, could interrupt or degrade the flow of data, perhaps for years.

The Government's Role

Only one organization can assure data continuity--the U.S. Government. I believe the government should provide the system with sufficient safety factors by procuring spare satellites and specifying early launch readiness, so that an uninterrupted flow of data is available through 1988 and beyond. Because of the lead times required, this action should begin with provision for long-lead item procurement in the FY'83 budget.

Once continuity is assured, other central issues, such as the feasibility of operating the system as a commercial venture, can be addressed more confidently. This process will also require long periods of time, and the government's continuity planning must assume that a protracted transition period must be supported to do a valid assessment.

Is Commercial Operation Feasible?

Is commercial operation a practical concept today? From a business perspective, I have examined it carefully and have serious concerns and doubts. Through NASA's R&D programs, Landsat has developed a wide diversity of applications, and demonstrated that the system can deliver immense value to the national economy. Many organizations from all over the world have bought and used data. Nevertheless, the system has few operational users; that is, few organizations have adapted the data for regular routine use in their missions, and thus can assign a dollars-and-cents value to it. Consequently, I question whether these users constitute a base market upon which to build a business. I haven't seen any meaningful market figures which would convince me that they do. There are uncertainties about the level of service that such a market can support, and this raises questions also about cost levels, capital requirements, and other vital business factors.

Among those capital requirements, by the way, would be on-orbit spare satellites to maintain the data continuity which we have identified as a necessity for any viable system. How would an entrepreneur finance this hardware, costing more than $100 million, and how would he get a fair return on his sizeable risk? Would he also assume a share of the costs of the Tracking and Data Relay system, and how would he recover this?

The Revenue Question

I'm convinced that a land remote sensing system can produce benefits to the nation which are measured in hundreds of millions of dollars, or even more. If an operational system had been in place at the time of the Russian wheat deal, for example, data about the Russian crop failure could have produced financial benefit of that magnitude to American farmers, food processors, commodity brokers, and ultimately, the taxpayer. The U.S. Government, as the dominant user of the data and dispenser of its benefits, could have provided the country with a significant public service, actually measurable in dollars. If on the other hand, a private entrepreneur had been operating the system at that time, he might have wanted to receive revenues which were proportionate to the value of the service he performed, but he would have had no way of collecting them.

The oil and mineral extraction industries and a few other private sector users are exceptions, but in the majority of cases, benefits from the Landsat system can yield significant monetary value only by distribution through governments. Free market forces could not create revenues under such conditions, and government would therefore have to provide them.

Another impediment to free market operation may be the problems that a private venture would have in competing with foreign competitors that are backed by their governments, such as the planned French SPOT system. To build and maintain a world market could be difficult, or even impossible, because of the financial advantage such foreign competition would have. The U.S. Government might have to intervene financially here, as well.

So, both to maintain the public service functions for the American taxpayer, and to sustain a competitive position internationally, substantial subsidies from the government might be necessary. But present policy, with which, incidentally, I am in full agreement, is that such subsidies should not be paid. And without them, there is a very sketchy, and obviously inadequate guarantee of a large enough market to sustain a private enterprise.

Other Market Issues

Aside from its purely financial aspects, the market issue raises additional institutional and procedural questions. I am not sure, for example, that adequate means are available today to identify, measure, and develop the remote-sensing market with its broad spectrum of real and potential users. Since the government is now the market for about half of the data, its future role and responsibility in providing a continued market is a real concern. And, of course, there is the question of sustaining R&D, which is now NASA's role. Would a prospective entrepreneur be expected to take this over? If so, how would he transfer new applications technology to users?

Such issues are large and concrete, while the data base available to resolve them is small and speculative. Given the size of the identifiable market, the large front-end costs, and the prospect of many years of investment before any recovery can be expected, I have serious doubts that most businessmen would choose to enter land remote sensing as a commercial venture today, or if they would, that they would be successful.

Sufficient Time Needed

Nevertheless, we can expect continued pressure to recast the system into some kind of a commercial enterprise. I think we should ask ourselves whether pressure alone can suddenly produce answers to questions that have challenged our most knowledgeable and experienced people for virtually the entire life of the program.

We ought to be confident that, given enough time, the issues surrounding the advancement of users' capabilities and their commitment to the system can be resolved; that Government as the dominant data user can aggregate the market and place a credible value on it; and that the proper relationships with the international community--diplomatic, cooperative, and competitive--can be established, including, incidentally, equitable agreements with nations which have their own ground stations. But to rush precipitously into any mode of system transition before this formidable array of issues has been resolved is to jeopardize the investment of the Government, and the interests of the user community.

Summary

It has taken nine years of experimental effort to establish the utility of Landsat. The system represents a $1 billion investment. Prudence and good business judgment dictate that we think of our payoff only on a long-term basis. If the future of the system includes commercial operation or ownership, the provision of data continuity, and a systematic approach to market aggregation, will be necessary and valuable preparations for the transition. In my view, these preparations will take many years and much dedicated effort.

Conclusion

At this stage, the primary concern of all of us should be to preserve the integrity of the system we have, and protect our national investment. These two subcommittees have always shown commendable initiative in advancing the interest of the program. I hope that the suggestions I have made today will be of value in the continuance of that initiative and interest.

Thank you.

Senate Subcommittee on Science, Technology and Space
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

Hearing on Civil Land Remote Sensing System
July 23, 1981

Questions for
Mr. A. J. Rosenberg, Vice President, General Electric Co.,
General Manager, Space Systems Division

1. Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

   ANSWER:

   The non-discriminatory distribution policy has fostered the development of applications technology in the United States, particularly by universities and state government bureaus which must operate on limited budgets for this type of research. Non-discriminatory provision of data to foreign governments has also been a factor in promoting worldwide use of the system and in maintaining the technological leadership posture of the United States. Continuation of this policy would promote further worldwide use of the system and advancement of applications technology, particularly important when Thematic Mapper data becomes available to the worldwide community of users.

   If this policy were to be changed, a number of domestic users and investigators may decrease the level of their applications and research, as indicated by testimony at the recent hearings. It may also prove to be difficult, or even impossible, to arrive at an equitable differential pricing policy, whether it be based on the ability of the user to pay, or on the monetary value of the data as determined by its usage, or even by the real net cost of gathering, processing, and distributing data.

   Discriminatory distribution policy by a Government operator of the system would almost certainly cause resentment, and perhaps litigation, over presumed unfair and arbitrary treatment of some user groups. The same policy carried out by a private entrepreneur would be resented as monopolistic and exploitive, particularly by foreign governments which have been some of the Landsat system's strongest supporters.

2. The Government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

   ANSWER:

   From the beginning of the program, various investigators have tried to specify minimum operational systems which would function at lowest possible cost. Their efforts have generally been directed toward:

Standardization - if families of data products could be developed in standard formats, economies might be effected in data gathering, processing and distribution.

Combined operations - it may be possible to fly several missions which have common resolution or frequency requirements on single platforms and thus effect economies in data gathering.

Duplication - by combining operations in correction, processing, data base management, and distribution, duplications may be eliminated and economies of scale effected.

Before these economies can be effected, however, the market must be carefully identified and its requirements specified. In my opinion, this process has only begun, and much dedicated effort will be needed to assure compatibility between the needs of the users and the prospect of realistic cost reduction.

3. Are you aware of aggressive marketing by the French for SPOT data?

ANSWER:

Yes. They have promoted their system industriously to prospective users, private and government, in this country and abroad. While their initial interest seems to be centered on users interested in exploration for minerals and other non-renewable resources, they are representing their system as potentially having much of the capability of the Landsat system.

4. What are your views on single entity operation of the system vs. competition for the various segments of the system?

ANSWER:

A single entity would obviously be better able to supply an end-to-end service, and to keep an equitable balance among the needs of all users for resolution, frequency, turnaround time, correction, archiving, and applications development. The operators of segmented systems would obviously have much narrower interests, and would tend to respond mostly to the needs of those users whose business promised the highest short-term return, neglecting many important missions and functions. The strength of the Landsat system derives from its purposeful development to serve the widest possible community of users, and to advance applications on the broadest possible front. This strength would be dissipated if the system became fragmented into segments to be operated by various entities.

5. You state that the government should provide the system with sufficient safety factors by procuring satellites and specifying early launch readiness so that an uninterrupted flow of data is available through 1988 and beyond and we should begin with long-lead procurement in FY 1983. What then is the incentive for private industry to get involved in the system at all? Do we have then, the next 10 years like the past ten years?

ANSWER:

One of the best incentives for private industry involvement in the program is the assurance that data flow will continue long enough to provide proper market development and orderly transition to operational status. With this assurance, private industry can assess the commercial possibilities of the system realistically and deliberately, and can negotiate with the Government secure in the knowledge that all cost factors are known.

In my view, incentives for private industry involvement would be much stronger with data continuity guaranteed and all hardware in place for an initial operating period, than they would with continuity uncertain. The prospect of an immediate requirement for sizeable capital investment to produce and fly new space vehicles and sensors would be a strong disincentive to any entrepreneur.

If the commercial potential of the Landsat system is as inviting as some advocates believe it to be, the primary concern at this time, as I said in my testimony, should be to preserve the integrity of the system we now have. Any transition to a more advanced status can then be done reasonably and systematically without undue pressures caused by time factors. In my view, this end will be well served by assuring an uninterrupted flow of data at least through this decade.

6. How good do you feel the government is at marketing--if it should be marketing at all? Most experience proves the government a poor marketer. So, how can we expect market aggregation from another 10 years of a government system--we have already had 9 years of experimental effort on Landsat data?

ANSWER:

Historically, the U. S. Government has not shown any outstanding aptitude for the marketing of products and services, and there is serious doubt that this is a proper role for government.

The Government, however, could have an essential role in aggregation of the land remote sensing market, if the term "aggregation" is given a specific and concrete definition. It must mean a mandated adoption of land remote sensing data, methods, and services by all Government bureaus and agencies whose missions and functions can be done more efficiently, more economically, or more accurately through remote sensing than through existing methodology.

Such a mandate, whether carried out by the Government itself or done through contracted services, is the essential first step in transition from experimental to operational status for the Landsat program. The Government is the principal user of Landsat data and services, and the only agency through which the benefits of the Landsat program can be distributed equitably to its ultimate beneficiaries. It is therefore the only entity which can direct that Landsat data and methodology are used to maximum advantage for all possible Government missions. Without such a mandate, there is every probability that the program will necessarily continue on an experimental basis for some indefinite period, or that attempts to commercialize the system through voluntary participation by Government agencies will result in failure, jeopardizing the program's future and the taxpayers investment in it.

Response by Mr. A. J. Rosenberg to the House Subcommittee on Space Science and Application

1. (a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

ANSWER:

There are two general areas of commonality in which missions can be effectively grouped. The first is in resolution level. Ten meter resolution has been specified as a common requirement for certain geologic, small-scale agricultural, and land use planning missions. Thirty meter resolution is thought of as an adequate level for large-scale crop prediction, hydrologic, forest management, and land use missions. Eighty meter resolution is satisfactory for synoptic surveys of a wide variety of resource missions. Appropriate combination may thus be possible and practical.

There also may be opportunities for mounting multiple missions on single platforms if the requirements for frequency of observation are compatible. Certain geologic, agricultural, and hydrologic phenomena, for example, can best be observed on a seasonal basis, while crop prediction and environmental missions could require observations every few days. Such commonalities in mission requirements will determine whether dedicated satellites or combined platforms would be the most necessary and efficient system configurations.

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

ANSWER:

The frequency and resolution factors cited above would be operative in considering combinations of weather and land sensing satellites. Effective weather forecasting, particularly the tracking of large systems, requires several observations daily at large scale and relatively low resolution. Such frequency and resolution would be of little utility in agricultural, geologic, or land use planning missions, for example. Thus, although it is theoretically possible to perform weather and land sensing missions from a single satellite, or even through a single sensor, the range and versatility of such observations could be so severely compromised as to be impractical for either mission.

Since efficient satellite communications are best supported by satellites in geosynchronous orbit, any attempt to mount land remote sensing missions on communications platforms would necessarily encounter severe problems with resolution, in addition to the obvious limitation implied by their fixed perspective and limited view of the earth's surface. Within the existing state of the art or the anticipated improvements in land remote sensing, it is difficult to see any advantage in trying to combine this mission with the communication mission. There may be advantages, however, in using future geosynchronous communication platforms as relay points in the transmission and distribution of land remote sensing data.

2. (a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

ANSWER:

As I stated in my testimony, the sensors of the Landsat-D configuration are fully ready to support operational missions, and the data processing complex will also fulfill the requirements of operational missions. The only impediments to a fully operational system are the limited abilities of some users to fully assimilate the benefits inherent in the data, and the unwillingness of some parts of the user community to make the necessary commitment in equipment and training because of the lack of assurance of data continuity.

(b) What is the applicability of LANDSAT-D to an operational system?

ANSWER:

Landsat-D was conceived as a quasi-operational system fully capable of supporting transition to fully operational status. I see no reason to change this conception of the system's capability.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

ANSWER:

In my opinion, we do not. Landsats 1, 2, and 3 have provided a total of 13 years of beneficial service. While Landsats D and D Prime may give a similar performance, there is a large and, in my opinion, unwarranted element of risk in basing the future of the program on an assumption that they will. A launch anomaly, a failure or degradation of the Thematic Mapper (as yet an untried system), or failures in the new system for data transmission through the Tracking and Data Relay Satellite may interrupt or degrade the service. In my view, the risks are high enough and the consequences of failure serious enough to warrant the provision of additional satellites to guarantee data continuity through the 1980's.

3. (a) By what process should responsibility for remote sensing move to the private sector?

ANSWER:

The only fair and equitable way to move this responsibility is through open competition for ownership and/or management of the entire system, rather than through any processes involving exclusive negotiations or segmentation of system responsibility. However, because of the uncertainties of the market, and the immense risk that purchase at any realistic price would involve, I have doubt that a valid competition could be held at this stage of the system's development.

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the questions of finances)?

ANSWER:

The General Electric Co. has performed for nine years the essential management and technical tasks necessary to support both the space and ground segments of an operational system, with the exception of the launch. From this experience, I can affirm that a number of private sector organizations could fulfill all the management and technical requirements for an operational system. Fulfilling the financial requirements, however, would be a formidable task for any organization which must answer to its stockholders.

(c) Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

ANSWER:

If by "monopoly" we mean the designation by competitive means of an entity as the sole agent of the U.S. Government, with exclusive rights to the government-sponsored market and protection from competition by the Government, the answer is yes. Such a monopoly would not only be necessary for efficient operation, but adequate protection of the private sector investment in such a venture would be impossible under any other conditions.

If such a monopoly would be granted in such a way as to encourage active market development and applications advances by the entrepreneur, it is unlikely that any detrimental effects would result. If, however, such an arrangement entitles the system owner to a continuing subsidy, to be paid irrespective of progress in market or technology development, the most likely result would be stagnation of the system and the danger of inroads by foreign competitors such as the SPOT system.

(d) How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

ANSWER:

Since the size of the government market, and the frequency, resolution, and turnaround requirements of the service to be provided are unknown, it is difficult to even estimate how much guaranteed revenue from all sources would be required to sustain an operational system. It is this uncertainty which has inhibited the private sector from specifying the dollar amounts of guarantees required for a feasible venture. In the absence of such concrete information, it would be difficult to determine whether any given level of government support should properly be called a "market guarantee" or a "subsidy."

If competition for initial ownership is diminished, it would more likely be attributable to market uncertainties and the prospective cost of technical development and innovation, rather than to the possibility of a subsidy per se.

(e) Is a copyright provision necessary for private sector operations?

ANSWER:

A copyright provision is absolutely necessary for private sector operation to protect the investment of an entrepreneur in the same way that the publishers of books and recorded music are protected. Such copyright provisions, however, may be difficult to enforce if foreign entrepreneurs operating in cooperation with their governments are able to offer data acquired through the operation of foreign-owned systems.

(f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

ANSWER:

If an entrepreneur could establish the value of the data to each user individually, and determine that each would be willing to make payments commensurate with that value, distribution and marketing of data on a discriminatory basis might be practical. The legislative and regulatory difficulties of any discriminatory system, however, could present substantial problems to any entrepreneur. Non-discriminatory marketing policies are more in keeping with commercial practice in the U.S., and could be done without any substantial modification to existing laws and regulations. It is this practice which has fostered the growth in utility and value of the data to a wide community of users, and has maintained the technological leadership posture of the U.S. in remote sensing.

(g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e. to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

ANSWER:

Under the existing concept of international law and common commercial practice, an independent company which obtained scenes of an area of the earth from its own satellite would have the same proprietary rights as a commercial photographer does in photographs he takes of any scene generally accessible to the public. This includes copyright and proprietary rights in sales and distribution.

The rights of landowners and foreign nations are more ambiguous, but the most commonly accepted concept is that space at altitudes in the Landsat regime is not subject to national or private jurisdiction, and thus no territorial or property rights exist in space any more than they do on the high seas. It is possible, however, that treaties or U.N. protocols may define this more closely in the future, and that international agreements setting forth individual and national rights to space-acquired data may be drawn.

(h) How should a private sector operator be regulated, if at all?

ANSWER:

Adequate precedents exist for regulation of the activities of any private sector operator. The operator, if able to overcome the market and investment difficulties inherent in commercialization, would probably function as a franchised service with provisions more or less as follows:

1. He would be protected from competition.
2. He would be required to provide a given level of service.
3. His pricing policy would be restricted to agreed limits.
4. He would be restricted from expansion into other fields of technology or missions.
5. He would be responsive to a quasi-public board, most likely composed of users, which would have some voice in significant system operations.
6. His performance would be subject to periodic review by cognizant Government authority.

(i) Who should do R&D? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

ANSWER:

R&D is such an expensive and risky operation that only the Government can do it effectively. Recent experience in communications R&D, in which the private sector was unwilling or unable to take over R&D from NASA, and thus lost ground in competition with foreign entities, should be instructive in making this determination.

(j) How should the sale price for government equipment be determined for a transfer to the private sector?

ANSWER:

If the assets were to be priced at or near their real cost or replacement value, the only fair way to make such a transfer, valid precedents exist. The first recourse should be to negotiations under the traditional advocacy system which has always prevailed between Government and the private sector. If this fails to produce agreement, the good offices of a knowledgeable and neutral third party could be employed in relevant fact-finding. There are also various formulas, involving replacement value, depreciation, interest rates etc., commonly used in commercial business, which might be agreed upon as a basis for equitable pricing.

(k) If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

(i) With respect to continuity?

(ii) With respect to technical development?

(iii) With respect to market preparation?

ANSWER:

(i) Certainly Government retention of responsibility for maintenance of data continuity would be advantageous in any operational system.

(ii) Also, as stated above, technical development in sensors, spacecraft, data systems and applications should be wholly or in part a continuing Government responsibility.

(iii) Since the Government is the principal market for data, it would also have important responsibilities in market preparation and aggregation as the initial step in transition to a privately owned space segment. It would be important, however, to have specific agreement on the duration and extent of such Government functions. Without such agreement there would be a tendency for the Government to exert continued control over space segment operation, making it extremely difficult for any private entrepreneur to bring such operation into conformance with commercial practice.

(1) What would joint ventures between government and businesses contribute to the present system? Is legislation necessary to permit joint ventures?

ANSWER:

In my opinion, any private sector venture in the present system would be a de facto joint venture in which the Government would share losses, since the existing market cannot enable any entrepreneur to recover his costs, let alone show a profit. Since a joint venture would confer upon the Government ambiguous roles as underwriter, entrepreneur, and customer it is difficult to see what advantage such an arrangement could provide.

If such an arrangement would be contemplated, enabling legislation would certainly be necessary. It would be inordinately difficult to draft and enact such legislation, given the difficulty in defining the obligations and entitlements such an arrangement would require.

4. (a) How is the contribution of universities important?

ANSWER:

The university community has made substantial contributions at very low cost to both technical and applications research in remote sensing. This is important because only in a university is it possible to train future participants in the system in the cross-disciplinary methods necessary for best use of the system. Universities are also important sources of technology and talent which are readily available to associated state governments which wish to take advantage of land remote sensing, but lack adequate budgets and trained manpower.

(b) What should be the role of universities in the future, i.e., if we have an operational system? What should be the role of the Federal Government vis-a-vis universities?

ANSWER:

The Federal Government should support land remote sensing R&D in the universities in the same way it supports other basic and applied sciences. A private operator could also fund universities for specific tasks. Adequate precedents exist for support of such activities through both programmatic and disciplinary grants.

The Federal Government, however, should not establish such research objectives directly, but should work through user boards and other impartial bodies in determining objectives and methods.

(c) How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

ANSWER:

This Sub-committee recently heard testimony that the prospect of higher pricing for data and services, which would necessarily accompany system commercialization, would result in a reduction in university remote sensing programs.

There is also a danger that an entrepreneur would regard universities as very poor prospects for profitable marketing, and thus would neglect their needs. It is difficult to conceive of any benefits which universities would derive from commercialization of land remote sensing.

5. (a) How is the utilization of remote sensing data important to the public welfare and health?

ANSWER:

In the largest sense, the mission of land remote sensing is efficient management of renewable and non-renewable resources and preservation of a healthy environment. Although these objectives impinge on private interests, they are nearly all macro-missions whose benefits can be aggregated and distributed only by Government. Thus by its synoptic scale of operation, remote sensing must necessarily be an instrument of public policy.

(b) To what extent are State and Local Governments utilizing this data for public services?

ANSWER:

Testimony in the recent hearings on land remote sensing has shown that as many as 35 states and several regional bodies are active users of data. A large proportion of the missions supported by land remote sensing at the state and local level is undertaken in the execution of federal mandates in such areas as coastal zone management and public land inventory. The consensus is that there are many more missions at the state and local levels which can be done most efficiently through land remote sensing, but that local governments have been slow to commit the necessary funds and manpower because they have had no assurance of the continuity of the data flow.

(c) What are the primary concerns of the state governments

(i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3?

(ii) with the future commercialization of land remote sensing?

ANSWER:

(i) Administratively, there would be very little difference. Many state governments, however, are concerned that the reductions of funds for technology transfer which will occur at the end of the present fiscal year will make it extremely difficult for states to adapt to the higher resolution and additional spectral bands provided by the Landsat-D Thematic Mapper. Technical improvements such as these could make the system much more valuable to state governments in such missions as land use planning, but without the means for development of applications technology, these prospective benefits may never be realized.

(ii) Competent witnesses have testified about the apprehension with which state governments regard the prospect of commercial operation of the land remote sensing system. State budgets for such missions are small, and as a prospective market segment, would offer an entrepreneur relatively little incentive. State governments say they fear that under these circumstances the needs of the states under a commercial system would be neglected.

6. (a) Is present data receipt and handling centralized? What are the advantages and disadvantages.

ANSWER:

Data receipt and correction are centralized at the NASA Goddard Space Flight Center. Their handling, archiving and distribution are centralized at the Earth Resource Observation Service in Sioux Falls, South Dakota.

The advantages of such centralization are obvious: economies of scale, concentration of resources such as skilled manpower, and the ability to manage technology development on a system basis so as to benefit the entire community users. The major disadvantage of the present system is the division of responsibility and duplication of facilities between Goddard and EROS. There is a growing feeling that these services should be consolidated, both administratively and geographically. Since data can be moved rapidly to any point on earth via satellite, there would appear to be no disadvantage to centralization.

(b) Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

ANSWER:

Such systems have been postulated on the theory that data gathering, processing, and distribution could more efficiently be handled by discipline, i.e., geology, agriculture, hydrology, etc., or from geographically dispersed centers. However, the obvious advantages of centralization and the availability of efficient means for rapid distribution through satellite networks seem to outweigh by far the advantages of decentralization of any system elements.

7. (a) For a government-operated system, should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

ANSWER:

There are only two logical ways to manage the pricing of data.

1) The cost-based method. The system operator should be able to establish exactly how much each product and service costs him and to pass this price on to the user with the necessary adders for profit, depreciation, interest rate, overhead, etc., according to standard business practice. This method requires no arbitrary judgements by the system operator, and can best be defended on the basis of equitability and consistency with existing laws and commercial practices.

2) The benefit-based method. Under such a system, the system operator would assign a price to each product and service which would be based on the benefit conferred upon each user, regardless of what it cost the operator to produce it. This is a classic pricing policy of a theoretical monopoly, and is typified today by the pricing mechanism used by the OPEC nations. Such a system would necessarily involve arbitrary judgements as to what the benefits are worth to a user. It would be extremely vulnerable to competitive systems, particularly foreign systems supported by their governments.

(b) If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?

ANSWER:

There is a sharp division of opinion on the question of whether the Government should recover either capital or operating costs of a land remote sensing system. Well-informed observers note that the Department of Agriculture conducts enormous research and technology transfer programs at no direct cost to its beneficiaries, as do the U.S. Geologic Service, the Corps of Engineers, the Bureau of Standards, the Public Health Services, and many other Government-supported enterprises in the development and transfer of technology. Since remote sensing data users are by and large Government units themselves, it is difficult to establish a rationale for singling out land remote sensing as the one area of Government-sponsored technology which is under obligation to recover its development or operating costs. If this requirement were to be applied to other Government sponsored R&D and technology transfer operations, the technical infrastructure of the nation would suffer. Consistency and logic therefore would seem to be on the side of those who believe that Government should not be required to recover its costs in land remote sensing.

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

ANSWER:

Since approximately half of the market of any private system operator would be the Federal Government, pricing agreements and guidelines which would apply to all Federal Government users would necessarily become part of the marketing mechanism. In addition, if discriminatory pricing policies were contemplated by the private system operator, they would have to be supported by federal legislation, which would inevitably be necessary to clarify and apply them. It is tempting to believe that a private system could be operated under pricing policies determined strictly by the classic market processes, but when the operation, and indeed the survival of the system, depends upon the Government as the major part of the marketplace, significant influence on pricing policy by Government and the promulgation of the resultant regulations would be inevitable.

8. (a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

ANSWER:

In two decades the United States has spent about ten billion dollars and launched more than 50 spacecraft dedicated to remote sensing of the earth. More than 40 countries regularly purchase data provided by the U.S. Landsat satellites, and 120 can receive weather data from space collected by U.S. satellites. Ten countries are able, or soon will be able to receive data from land observation satellites by use of their own ground stations.

It is my impression that both previous and present administrations have approved this level of activity by making specific provisions to sustain it. By providing for transition beyond the present experimental phase, the two administrations have recognized the potential value and importance of land remote sensing, supporting continued dissemination and use of the data, and providing for future development of the system to the late 1980's.

(b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

ANSWER:

Present Government policy on land remote sensing was set during an era which gave cost reduction in Government operations the highest priority. Requirements for support of remote sensing were balanced against the demands of the larger fiscal objectives. The near-term result has been an attempt to accelerate system evolution to operational status in a manner which will achieve two main objectives:

i. Foster the development of the sytem by applying the entrepreneurial thrust of the private sector to the marketing of data and services.

ii. Relieve the Government of the system operating costs by transferring this burden to the users.

Advocates of land remote sensing are hopeful that these objectives will serve the best interest of the system and its users. However, they are also mindful that neglect of the critical market and investment risk factors could well produce a result which would neither achieve the Government's objectives nor safeguard the potential of the system as an effective instrument of national policy.

Mr. **Flippo**. Thank you very much, Mr. Rosenberg. They will indeed contribute to our deliberations.

Mr. Charyk, we are delighted to have your testimony.

STATEMENT OF DR. JOSEPH V. CHARYK, PRESIDENT AND CHIEF EXECUTIVE OFFICER, COMSAT GENERAL CORP.

Dr. **Charyk**. Thank you, Mr. Chairman.

I am pleased to have this opportunity to appear today to present Comsat's views on civil remote sensing systems, the transition to the private sector, and the role which Comsat is prepared to play with respect to an operational civil remote sensing system. Although the subject of these hearings is the civil land remote sensing system, I will, with your indulgence, also address the subject of meteorological satellite systems.

We believe that land observation satellites and meteorological satellites should be considered together viewed as an integrated Earth environmental monitoring system.

We believe that the United States should establish at the earliest possible date a new policy with respect to the evolution of all civil remote sensing systems. The enunciation of a clear policy and its implementation are necessary if the United States is to play a leadership role in this important application of space technology.

A major thrust of this policy would be premised on the principle that Government needs can be most economically served and a commercial market most effectively developed by assigning to the private sector the responsibility for ownership and operation of the remote sensing system.

We believe that the most expeditious means of implementing such a policy would be to designate by legislation an appropriate private entity with a proven record of performance, both domestically and internationally, the responsibility for operation of the civil remote sensing system and the evolution of an international system.

We believe Comsat is uniquely qualified to be so designated based on its long and successful experience in the establishment and operation of many satellite systems, its unique corporate structure, and its established relationships and responsibilities to the President and the Congress.

The GOES and NOAA satellite programs are fully operational. After many years of experimental status, the Landsat program is scheduled for transition to an operational status sometime after the launch of the Landsat-D satellite in 1982.

In order to realize the full benefits of remote sensing technology, a new civil remote sensing policy should be established at the earliest possible date. The major goals of such a policy should include the combination of the land and meteorological systems, the transfer of these systems to the private sector, and a commitment by the Government to meet its special needs through the utilization of the system established and operated by the private sector.

The advantages of combining the Landsat and NOAA/GOES systems arise from major economies of scale resulting from the elimination of duplicate facilities and from the nature of the data that can be produced.

Because they were developed and administered separately, the present Government programs have evolved with duplicative facilities. Combining the land and meteorological satellite programs would enable the operator to eliminate unnecessary facilities and reduce administrative support, reducing the overall cost of operating an integrated system.

Combining the programs also increases the value of the data to the user. The Earth's environmental processes are such that atmospheric, Earth, and oceanic processes are intimately intertwined.

Although many diverse sensors and satellite platforms are used to collect data, it is important that the collecting systems and the data produced by these systems be integrated as part of a global environmental observing system.

An integrated system would produce a variety of data, and reduce the time to assimulate several data sets.

The private sector can more effectively and economically meet both governmental and commercial needs, and will have a financial incentive to develop the private market.

Business necessity will stimulate the private sector operator to be more responsive to customer needs. A premium will be placed upon developing systems that deliver on time those data which diminish in value when not received promptly by the user.

The private sector, however, cannot expand the growth and development of remote sensing systems alone. The present sales revenue from non-Government customers is small compared to the investment required and, therefore, could not form the basis of a commercially viable business on its own. Thus, a Government commitment is required to procure its data and data products from the commercial system.

This Nation is at an important crossroad with regard to its civilian remote-sensing programs. Prompt action will bring to an end the repeated delays and frustrated attempts to commercialize civilian remote-sensing activities and ensure the continued uninterrupted flow of data from U.S. land remote-sensing programs.

Accelerated commercialization will also enhance the position of the U.S. remote-sensing industry in the face of growing competition from foreign suppliers of data and services.

There is no question that the United States is engaged in a contest with other nations to develop commercial remote sensing applications. The French have begun construction of the SPOT satellite which they plan to launch in early 1984. Of particular value to petroleum and mineral exploration interests, this system's high resolution, stereoscopic data will be sold through a commercial entity specifically created by the French Government to aggressively expand the commercial market for SPOT products worldwide.

The Japanese Ministry of Industry and Trade has also announced plans to build satellites which would include a high resolution stereoscopic capability, as well as a synthetic aperature radar to measure sea-state phenomena of importance with regard to fishing harvests and oil tanker operations.

Users of remotely sensed data in the United States, including Government agencies, may have no choice, but to become customers of these foreign programs if commercial U.S. systems using advanced technology are not developed in a timely manner.

Under a private sector owner/operator, the commercialization of civilian remote-sensing services would be accelerated and new sensors, data products, and services introduced, thereby assuring the United States leadership in commercial space applications would not only be preserved, but significantly enhanced.

Transfer of civilian remote-sensing systems to the private sector will require a cooperative effort on the part of both the Congress and the administration. From the standpoint of simplicity, prompt action, and assured results, the most effective means by which to effect this transfer is through legislation which would designate an appropriate private entity.

We think Comsat is uniquely qualified to be so designated. As the designated entity, Comsat would be prepared to assume responsibility on a commercially viable basis for the development of satellite remote sensing, including the major functions associated with planning, operating, and managing the remote-sensing system and marketing its data products.

To this end, we have developed and presented to the executive branch for its consideration our Earthstar plan, by which we would effect the transfer of the civilian land and meteorological programs to the private sector by purchasing under appropriate terms and conditions certain elements of the GOES, NOAA, and Landsat satellites, and certain related ground equipment from the Government.

Our plan would be to consolidate these three remote-sensing programs into a single, integrated commercial system. We would, indeed, contract to meet the Government's civilian remote-sensing requirements for data and data products.

The necessary supervision of Comsat's activities as the designated entity can be accomplished through this contractual arrangement and through appropriate provisions in the legislation.

If implemented, our plan could reduce overall Federal expenditure by saving the Government, we believe, several hundred million dollars in operating costs and increase the Federal tax base. Users would benefit from our plans to improve the timeliness of data and increase the diversity of data products.

In addition, we would seek aggressively to implement new technology and to improve our data acquisition capabilities. Such technical improvements, coupled with a vigorous marketing effort, will accelerate the commercialization of remote-sensing applications, thereby strengthening U.S. leadership in commercial space applications and exerting a positive influence on our economy.

In summary, Mr. Chairman, Comsat urges that a new civilian remote-sensing satellite policy be established for the commercialization and transfer of the Government programs to the private sector. The keystone of such a policy should be the designation of an appropriate private sector entity to assume the responsibility for the development of a single integrated Earth environmental observation system to meet the needs of Government and private users.

Furthermore, we believe Comsat is the logical entity to assume such a responsibility. If so designated, Comsat is prepared to proceed to dedicate the resources necessary for the successful development of such a system.

Thank you, Mr. Chairman.

[The prepared statement, plus answers to questions asked of Dr. Charyk follow:]

Statement
of
Dr. Joseph V. Charyk
President and Chief Executive Officer
Communications Satellite Corporation

Before the
Subcommittee on Space Science and Applications
of the
House Committee on Science and Technology
and
Subcommittee on Science, Technology, and Space
of the
Senate Committee on Commerce, Science, and Transportation
July 23, 1981

Introduction

Mr. Chairman, I am pleased to appear before you today to present COMSAT's views on civil remote sensing systems, their transition to the private sector, and the role which COMSAT is prepared to play with respect to an operational civil remote sensing system. Although the subject of these hearings is the civil land remote sensing system, I will, with your indulgence, also address the subject of meteorological satellite systems. We think that land observation satellites and meteorological satellites should be viewed as an integrated earth environmental monitoring system and should therefore be considered together.

COMSAT Position

- We believe that the United States should establish, at the earliest possible date, a new policy with respect to the evolution of all civil remote sensing systems. The enunication of a clear policy and its implementation are necessary if the United States is to play a leadership role in this important application of space technology.
- A major thrust of this policy would be premised on the principle that government needs can be most economically served and a commercial market most effectively developed by assigning to the private sector the responsibility for ownership and operation of the U.S. remote sensing system.

- The most expeditious means of implementing such a policy would be to designate by legislation an appropriate private entity with a proven record of performance, both domestically and internationally, to assume the responsibility for operation of the civil remote sensing system and the evolution of an international system.
- We think COMSAT is uniquely qualified to be so designated based on its long and successful experience in the establishment and operation of many satellite systems, its structure and its unique establisned relationships with and responsibilities to the President and the Congress.

Need for New Civil Remote Sensing Policy

The GOES and NOAA satellite programs are fully operational and, after many years of experimental status, the LANDSAT program is scheduled for transition to an operational status sometime after the launch of the LANDSAT D satellite in 1982. A coherent policy for the commercial development of these operational remote sensing capabilities must be established if the United States is to maintain its leadership in this field.

The impact of establishing such a policy is amply illustrated by the development of international communications since the passage of the Communications Satellite Act of 1962. Before passage of the Act, the application of the benefits of satellite communications was limited as a result of debates over who could best advance the technology, what technical route should be followed, and whether the technology was sufficiently developed for commercial implementation. Once a policy of commercialization by the private sector was established and an appropriate entity created, international satellite communications began to grow at an astounding pace. Only two years after COMSAT was formed it was leasing sixty international communications circuits to AT&T. By February of this year the number of circuits leased to the international carriers had increased to 10,000, and is expected to double by 1985.

In order to realize the full benefits of remote sensing technology, a new civil remote sensing policy should be established at the earliest possible date. The major goals of such a policy should include the combination of the land and meteorological systems, the transfer of these systems to the private sector, and a commitment by the Government to meet its particular needs through the utilization of the system established and operated by the private sector.

Combined Land and Meteorological Systems

The advantages of combining the LANDSAT and NOAA/GOES systems arise from major economies of scale resulting from the elimination of duplicate facilities and from the nature of the data that can be produced.

Because they were developed and administered separately, the present Government programs have evolved with duplicative facilities. Combining the land and meteorological satellite programs would enable the operator to eliminate unnecessary facilities and reduce administrative support, thereby reducing the overall cost of operating an integrated system. In addition, for the future, payload combinations may be possible with very significant economic benefits as a result.

A further economy can be achieved by a civilian owner/operator who has existing satellite facilities and an operations infrastructure. In addition to reducing costs, we believe consolidation will also increase procedural efficiencies and hasten the realization of national economic benefits available from remote sensing technologies.

Combining the programs also increases the value of the data to the user. The earth's environmental processes are such that atmospheric, earth and oceanic processes are intimately intertwined. Thus, although many diverse sensors and satellite platforms are used to collect data, it is important that the collecting systems and the data produced by these systems be integrated as part of a global environmental observing system. Data from meteorological and high resolution earth images can be combined to provide commercial products which are superior to those currently available.

Although weather and earth resources data products are interrelated, they now must be retrieved using different procedures from several agencies. The attendant delays have been a restraint on the development of a commercial marketplace. Timely, single point availability of all remote sensing data would be another benefit of combining these systems under a sole private operator.

Transfer to the Private Sector

We feel that the greatest progress in realizing the major benefits available from remote sensing applications can be achieved if these activities are pursued by the private sector. The private sector can more effectively and more economically meet both Government and commercial needs and certainly will have the necessary incentive to efficently develop the private market.

Business necessity will stimulate the private sector operator to be more responsive to customer needs. A premium will be placed upon developing procedures that deliver on time those data which diminish in value when not received promptly by the user. A commercial system will also best be able to accelerate changes in technology and delivery sub-systems to meet the needs of its customers. A private operator will aggressively seek new uses with social and economic value as a matter of sound business practice, thereby broadening the variety of products and reducing per unit costs for all users.

Role of the Federal Government

The private sector however cannot expand the growth and development of remote sensing systems alone. The present sales revenue from non-Government customers is small compared to the investment required and therefore could not form the basis of a commercially viable business. Thus, a Government commitment to procure its data and data products from the commercial system is required.

In this regard, the status of remote sensing today is similar to the situation in 1973 when COMSAT undertook the successful development of the world's first commercial maritime satellite communications system (MARISAT). Today more than 700 commercial ships and off-shore facilities use the MARISAT system for voice and data communications in support of their activities. This capability was made possible because development of the MARISAT system to meet a unique Government requirement provided a basis for a commercially viable maritime satellite communications system.

With Government support in the form of firm contracts to procure its data requirement from the private sector owner and operator of the system, further development of civil remote sensing could be undertaken in a manner which would provide benefits to both the Government and the private sector.

Need for Prompt Action

The nation is at an important crossroad with regard to its civilian remote sensing programs. Prompt action will bring to an end the repeated delays and frustrated attempts to commercialize civilian remote sensing activities and ensure the continued uninterrupted flow of data from U.S. land remote sensing programs.

Accelerated commercialization will also enhance the position of the U.S. remote sensing industry in the face of growing competition from foreign suppliers of data and services derived from non-U.S. remote sensing programs.

Mr. Chairman, there is no question that the United States is engaged in a contest with other nations to develop commercial remote sensing applications. France and Japan are embarking upon ambitious remote sensing programs as a means of developing and promoting indigenous aerospace and related industries required for data processing, interpretation, and distribution. The French have begun construction of the SPOT satellite which they plan to launch in early 1984. Of particular value to petroleum and mineral exploration interests, its high resolution, stereoscopic data will be sold through a commercial entity specifically created by the French government to aggressively expand the commercial market for SPOT products worldwide.

The Japanese Ministry of Industry and Trade has also announced plans to build satellites which would include a high resolution stereoscopic capability, as well as a synthetic aperture radar to measure sea state phenomena of importance to fishing harvests and oil tanker operations.

Users of remotely sensed data in the United States, including Government agencies, may have no choice but to become customers of these foreign programs if commercial U.S. systems using advanced technology are not developed in a timely manner. Under a private sector owner/operator, the commercialization of civilian remote sensing services would be acclerated and new sensors, data products, and services introduced, thereby assuring that the United States leadership in commercial space applications would not only be preserved but significantly enhanced.

Designated Entity Legislation

Transfer of civilian remote sensing systems to the private sector will require a cooperative effort on the part of both the Congress and the Administration. From the standpoint of simplicity, prompt action, and assured results, the most effective means by which to effect this transfer is legislation which would designate an appropriate private entity.

COMSAT's Unique Qualifications

Established pursuant to the Communications Satellite Act of 1962, COMSAT is a unique private corporation which has for nearly 20 years successfully met public needs and furthered national objectives through the development, operation, and use of communications satellite systems. COMSAT has accomplished this without financial assistance or subsidy from the Government, and efficiencies in operation have allowed us to make four successive rate reductions of 48.5, 15.5, 5, and 11.8 percent, respectively, for international satellite communications within the last three years.

Through COMSAT General, which was created in 1973, COMSAT has been able to apply the benefits of satellite technology to the U.S. domestic and specialized communications markets. In addition to establishing and operating the highly successful COMSTAR and MARISAT satellite systems, COMSAT General is a proven leader in developing and applying satellite communications to meet the problems of measuring and interpreting environmental conditions at remote terrestrial locations. In 1977-78 COMSAT General, together with the U.S. Geological Survey (USGS) and Telesat of Canada, developed and successfully tested the first use of commercial satellites for relaying real-time water height data collected from 13 remote sites in Oregon, Pennsylvania and Canada to a central location. Since August 1980, COMSAT General has established and operated data collection platforms in five separate regions of the United States. These platforms, which now number 105, monitor water stages and transmit the collected data through the Government's GOES satellite to a central receive and processing facility. Corrected and enhanced data products are then delivered to the USGS headquarters in Reston, Virginia and to cooperating users in Arizona, Colorado, New England, Pennsylvania, and Texas. This pilot program, sponsored by the USGS, has demonstrated the potentially enormous value of combining remote collection and transmission of data through satellites with interpretive skills and the power of computer processing to deliver operational and management information where, when and in the form it is needed, virtually instantaneously.

COMSAT Prepared to Proceed

As the designated entity, COMSAT would be prepared to assume responsibility on a commercially viable basis for the development of satellite remote sensing, including the major functions associated with planning, operating, and managing the remote sensing system and marketing its data products. To this end we have developed and presented to the Executive Branch for its consideration our EARTHSTAR plan by which we would effect the transfer of the civilian land and meteorological programs to the private sector by purchasing under appropriate terms and conditions the GOES, NOAA and LANDSAT satellites and certain related ground equipment from the Government, and consolidating these three remote sensing programs into a single, integrated commercial system. We would, in turn, contract to meet the Government's civilian remote sensing requirements for data and data products. Furthermore, we would edit, verify, format, and archive data for domestic and foreign users and make it available on a non-discriminatory basis under reasonable commercial terms and conditions. We would be prepared to conduct near-term product and service-oriented research and development, but we believe the Government should continue to have a responsibility for long-term research and development in which major technical unknowns are involved and the ultimate applications unclear.

The authority to dispose of Government facilities and to purchase data products and services to meet the Government's continuing requirements should be vested in a cabinet level official to be designated by the President. The necessary supervision of COMSAT's activities as the designated entity can be accomplished through contractual arrangements under which the Government would procure its requirements for data and data products, and through the exercise of the responsibilities assigned to the President by the legislation.

If implemented, we believe our plan could substantially reduce overall Federal expenditures and increase the Federal tax base as a result of new companies entering the market as well as from increased earnings from existing companies. Users would benefit from our plans to improve the timeliness of data and increase the diversity of data products. In addition, we would seek aggressively to implement new technology and to improve our data acquisition capabilities. Such technical improvements, coupled with a vigorous marketing effort, will accelerate the commercialization of remote sensing applications, thereby strengthening U.S. leadership in commercial space applications and exerting a positive influence on our economy.

Conclusion

In summary, Mr. Chairman, COMSAT urges that a new civilian remote sensing satellite policy be established for the commercialization and transfer of the government programs to the private sector. The keystone of such a policy should be the designation of an appropriate private sector entity to assume the responsibility for the development of a single integrated earth environmental observation system to meet the needs of Government and other users. Furthermore, we believe COMSAT is the logical entity to assume such a responsibility. If so designated, COMSAT is prepared to proceed to dedicate the resources necessary for the successful development of such a system.

RESPONSE BY DR. JOSEPH V. CHARYK TO SENATE QUESTIONS

(1) Our policy in the past has been one of non-discriminatory distribution of data. What are some of the advantages and disadvantages of changing this policy?

The United States has a strong policy that every nation has the right to gather data from outer space and to freely disseminate such data. This policy is firmly grounded in the provisions of the Outer Space Treaty which guarantee free and open access to use outer space and in our national policy which endorses the open dissemination and free flow of information between and among countries. Pursuant to those policies, the United States has conducted its civilian remote sensing activities so as to ensure the free and non-discriminatory access by all countries to civilian remotely sensed data.

We believe that the United States policy of non-discriminatory data distribution has been largely responsible for the success of the United States in preventing the adoption of international restrictions on the acquisition or dissemination of remotely sensed satellite data.

It is our opinion that the adherence to this policy by a commercial private civilian remote sensing satellite operator is essential to preclude any movement by third world countries to place restrictions on civilian remote sensing activities, whether conducted by the Government or private business.

(2) The government R&D systems have been fairly expensive, as they are experimental systems. In an operational system where do you see cost reductions possible?

Significant operational savings are possible by consolidating current satellite control, data acquisition, ground processing and distribution systems and eliminating non-operational activities. In addition, COMSAT currently has extension satellite operations which can absorb many Government agency functions, thereby using fewer people and facilities. A service network based on COMSAT's established communication and information transfer skills will more efficiently distribute data to bulk and individual users. Furthermore, an experimental system is by nature expensive. An operational system would cut costs by using proven and reliable technology designed and sized for commercial use.

(3) Are you aware of aggressive marketing by the French for SPOT Data?

We are very aware of the aggressive marketing efforts of the French for SPOT data. The French have created a quasi-commercial entity called SPOT-IMAGE to market the data produced by the SPOT satellites. We believe that the creation of SPOT underscores the necessity of the United States to move quickly to transfer remote sensing satellite activities to the private sector so that the commercial development of LANDSAT technology can proceed and so that the commercial development of LANDSAT technology can proceed and so that the United States may sustain its leadership in the application of new remote sensing technology and compete successfully with the French.

(4) What are your views on single entity operation of the system vs. competition for the various segments of the system?

As I stated in my testimony, we do not believe that owning and operating a LANDSAT system by itself is a very attractive business at present. However, since the Government market for meteorological data is well developed, the combination of the meteorological and land remote sensing systems would enable the orderly commercial development of the LANDSAT market. Furthermore, we view the separation between meteorological and land remote sensing as highly artificial, and we envision future systems and products as cutting across these present artificial lines. A combination would allow operational savings not only in the space segment, but would also permit a single operator to eliminate excess and duplicate facilities presently used to operate the meteorological and LANDSAT systems. Further advantages of a combined system would be more efficient mission operations and new service offerings. As examples, NOAA images which show cloud coverage could be used to schedule LANDSAT, and regional assessments of forest conditions could be combined with high resolution pictures of target areas.

(5) What amount of guaranteed government business would be required to make your concept viable?

We believe that the Government should contract for the procurement of data and data products which it currently receives and uses from the meteorological and land remote sensing systems. We believe that the Government could procure such data from a single commercial operator at a price which would be substantially lower than current Government expenditures on such systems. The private operator could then have a solid base of operation from which it could develop the commercial markets for meteorological and land remote sensing data.

As I stated in my testimony, the development of the MARISAT satellite system is very analagous. There was an undeveloped commercial market for maritime satellite communications which could not support a dedicated satellite system. At the same time, the U.S. Navy needed international communications satellite services. Therefore, we proposed that the Navy lease a portion of the satellite using its own frequencies and then the commercial sector would have to bear only a fraction of the cost of the system. This provided an economically sound basis for the development of a commercial market.

RESPONSE BY DR. JOSEPH V. CHARYK TO HOUSE QUESTIONS

(1) The following questions deal with the focus and scope of an Operational Civil Land Remote Sensing System.

(a) What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be served by a single satellite or system of satellites?

Satellites are necessary to observe global and/or synoptic environmental resources. The number of platforms used and their precise orbits are based on the synoptic time scale of the events to be monitored and the type of sensor being used. Sensors with multiple applications can be combined on the same platform. Thus, weather, sea condition, and high resolution land images will be combined in the future in much the same way that COMSAT intends to combine the ground systems now.

(b) Specifically, could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

Yes. COMSAT has studied ways to improve services and reduce cost by consolidating satellite and ground systems.

(2) Experimental remote sensing from space has existed for almost a decade. The following questions deal with the present status of LANDSAT system and whether the system should be operational now.

(a) What is your opinion of the present status of LANDSAT? Is it ready for operational use?

Currently operating LANDSAT satellites must be considered unreliable for providing continuous data to operational users. LANDSATs 2 and 3 are providing some data, but there is a serious question as to their longevity.

(b) What is the applicability of LANDSAT D to an operational system?

The LANDSAT-D satellite has both a multi-spectral scanner sensor and a thematic mapper sensor. The multi-spectral scanner sensor can be put into operational use almost immediately. However, the thematic mapper sensor is highly experimental at this stage and faces serious and fundamental design problems. The thematic mapper sensor cannot be considered to be operational at this time since there is no assurance that it will work in a satisfactory manner. The operational potential of the thematic mapper sensor is very high, however, and if it proves to be a successful instrument, it could be incorporated into an operational system.

LANDSAT-D will provide the best multi-spectral high resolution imagery heretofore available and should greatly improve data available to industries and governments with petro-mining, land use, hydrographic, arctic commercial exploration, and agricultural interests. LANDSAT-D will also introduce several engineering and technology innovations that will improve data registration, recovery, and overall utility and, with private ownership and operation, could be considered the first step in an operational land remote sensing system.

(c) Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 80's with the present approved program?

No. LANDSAT-D is planned for launch next fall, and it is unlikely that it and LANDSAT-D' will provide service through the 1980's. However, COMSAT has studied ways to continue and improve a LANDSAT-type service.

(3) Policy issues relating to the proper government/private sector relationships and the scope of the involvement of the commercial sector are in need of further clarification.

(a) By what process should responsibility for remote sensing move to the private sector?

As I stated in my testimony, we believe that the most expeditious method of transferring the responsibility of remote sensing to the private sector would be by legislation.

(b) Do you believe that the private sector could successfully operate both the space and ground segments of an operational system (leaving aside the question of finances)?

We believe that it is absolutely essential that a private sector owner/operator handle both the space and the ground segments of an operational system. COMSAT operates both of these segments now for satellite communications and believes strongly that control and responsibility for an end-to-end system is essential to system performance and ultimate customer satisfaction and acceptance. The purpose of a remote sensing satellite system is the production of useful data. Therefore, the system must be designed and operated in a manner which will provide the most efficient production of the most valuable information product. Separate operational authority for the space and ground segments would destroy the system concept and defeat the goal of providing a high quality, efficient service.

> (c) Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

A single owner of an integrated remote sensing satellite system is necessary in order to achieve the potential economies and efficiencies of a combined system. We propose to combine the satellite control functions and the data handling functions as soon as possible. The combination of these functions will make it possible to eliminate the costly duplication of facilities, equipment, and personnel which currently exists because of the split agency jurisdictions in the NOAA/GOES and LANDSAT programs.

A single owner of an integrated system is also desirable from the standpoint of national security. It is desirable to establish certain responsibilities and controls by the President over any remote sensing satellite system in times of national disaster or emergency. A proliferation of remote sensing satellite systems owned and operated by a variety of persons at diverse locations would make the exercise of this responsibility more difficult.

A single owner and operator of an integrated system will require some protection, for a limited time, of the investment needed to acquire Government equipment and facilities. The LANDSAT system is extremely costly and not currently designed for operational efficiency, largely because it was designed as an experimental system. Furthermore, it is technologically stagnant. The purchaser of this equipment must have some protection against operators who would provide specialized services directed toward clients with the greatest ability to pay at least until such time as the owner has an opportunity to install or bring into service more efficient, economical, and technologically up-to-date satellites, equipment, and facilities.

The private owner and operator will also need some time to develop the commercial markets for remotely sensed data. This market development will require a substantial investment which should be protected at least for the lifetime of the Government satellites.

> (d) How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and thus inhibiting innovation?

There will be a significant economic benefit to the Government of combining the meteorological and land sensing programs. The Government market for meteorological data is very well developed with some potential for commercial sales.

The Government need for land data, however, is not as well defined and the commercial market not at all developed. The LANDSAT system, however, could not be operated commercially by itself without a charge to the Government for data which would be substantially out of proportion to the cost of data to commercial users, e.g., at present, the Government pays for everything except the cost to non-Government users of reproduction of the data even though the Government uses only about 60 percent of the data produced.

By combining the meteorological and land systems, an operator could assume ownership and operation of the LANDSAT system for incremental costs and use the meteorological business to leverage the development of the market for LANDSAT data.

(e) Is a copyright provision necessary for private sector operations?

Copyright protection is essential as a part of the framework within which the commercial viability of a remote sensing system operated by the private sector can be achieved. While no significant changes to the existing copyright laws are required by the contemplated arrangements, the unique nature of the data, data products, and institutional framework make certain clarifications essential to provide a clear legal framework within which the data can be protected.

> (f) Is the concept of non-discriminatory data access compatible with private sector involvement? How important is this concept?

We believe the concept of non-discriminatory access to data is completely compatible with private sector involvement and highly desirable from a commercial standpoint. As you know, the United States has been very successful in preventing attempts by some third world and eastern block countries to impose international controls on the acquisition and dissemination of data. This success is due, in large part, to the policy of the United States of non-discriminatory access to data. The transfer of the United States civil remote sensing activities to a private corporation will undoubtedly be watched closely by other nations. However, as State Department representatives have previously testified before Congress, most countries will not be concerned whether the U.S. Government or a private company conducts the remote sensing, as long as the data policy remains unchanged. However, a change in the policy of non-discriminatory access to data could result in the passage of the measures we have so long resisted, with extremely unfortunate consequences for a business entry.

> (g) Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

We do not believe it is good public policy to allow restrictions on the access to data obtained by a remote sensing satellite system, except for national security or foreign policy reasons. We know of no internationally agreed upon principle which establishes any right in remotely sensed data by the sensed nation or the sensed landowner.

(h) How should a private sector operator be regulated, if at all?

To the extent that any regulation is required, we believe that it could be accomplished through a contract between the Government and the operator which governs the procurement of remotely sensed satellite data and products and through the oversight responsibilities which would undoubtedly be assigned to the President by the legislation.

(i) Who should do R&D? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

R&D has been, and should continue to be, a traditional and proper role for the Government. NASA has fulfilled this role, and we would hope that it would continue to participate in this essential area. As is the case now with the NOAA and GOES satellites, NASA could first introduce new sensor and associated data improvement and processing systems on either its own or on an operational systems satellite. Based on the success of this "Proof of Concept" step, these new technologies would continue as part of the operational system.

(j) How should the sale price for government equipment be determined for a transfer to the private sector?

It should be based on estimated "book value," useful lifetime, operational system need, and technical currency/obsolescence factors. For instance, new NOAA spacecraft would be purchased from the Government at cost. Existing ground equipment, if acquired, would be purchased based on the factors mentioned.

The sale price for Government equipment to be transferred should be established by negotiation between the executive branch and the company to which the property is being transferred. A negotiation is desirable because of the high number of variables involved and the relationship between the price of the equipment and the price of data.

> (k) If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?
>
> (i) With respect to continuity?
> (ii) With respect to technical development?
> (iii) With respect to market preparation?

Developing a remote sensing business is a high risk endeavor made less so if the risk taker has the broadest visability and greatest control of the total system possible. A hybrid system where the Government controls the data source and private enterprise sells goods and services would be an awkward and, we think, unworkable arrangement that would not promote continuity, user oriented systems designs, or real market development.

(1) What would joint ventures between government and business contribute to the present system? Is legislation necessary to permit joint ventures?

Joint ventures between Government and industry are little used but potentially valuable and beneficial arrangements. We foresee two areas of particular use for joint ventures. Ventures where the Government and industry orbit their own sensors on a shared satellite could be used to reduce the mission costs for both parties. Joint ventures could also be used to successfully bridge the gap between experimentation and commercial application in cooperative type missions. We believe that NASA has adequate authority to enter into these type arrangements and has implemented a policy to encourage joint endeavors with the private sector.

(4) Universities are currently involved in research and training in the area of remote sensing.

(a) How is the contribution of universities important?

Universities are a major contributor to applications research in multi-disciplinary areas utilizing remote sensing such as forestry, agriculture, hydrology, and geology. Significant advances in the use of computer aided analysis have come from university research, and several universities have established institutes to specifically focus on research involved with satellite remote sensing. Universities have and, we believe, will continue to make a major contribution to remote sensing advancement.

> (b) What should be the role of universities in the future, i.e. if we have an operational system? What should be the role of the Federal government vis-a-vis universities?

The role of universities during the period of an operational system will likely continue to be, in large part, to contribute to applications research. It is in this area that Government support to universities could be shared with industry and, specifically, joint endeavors or joint ventures could be established to focus on specific applications research with funding provided through sources other than federal programs. As in any case, the Federal Government should continue to support universities in fundamental research programs (i.e., Principal Investigators) that have proven so successful in the past for advanced sensor systems. This is consistent with NASA maintaining a strong leadership role in advancing sensor technologies that have ultimate use in an operational system.

> (c) How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

It is our belief that ultimately universities will greatly benefit by commercialization and expanded applications research since the marketplace will inevitably demand more specific software and analytical techniques that can be obtained from university research alone. The dangers to universities are, in large measure, related to the unknowns associated with commercialization. Programs in the past that have been deeply entrenched in the Government and by-products which have been made freely available to the universities engender an expectation of a continuity of products at little or no cost. Universities can well anticipate paying more for data obtained from a commercial operator but, at the same time, can expect improved services associated with deliveries of such products and services.

(5) Satellite data is being utilized to provide data for public services.

(a) How is the utilization of remote sensing data important to the public welfare and health?

Today, meteorological satellite remote sensing is the most mature source of data contributing to the public welfare and safety. The relatively mature utilization of these data is principally due to two factors: (1) the decisions taken in the 1960's and early-1970's to make these systems operational; and (2) the resulting emphasis on establishing products, services, and delivery networks directed to end-users, as well as the scientific community. As a result, data from GOES and TIROS are used to:

- identify the location of actual or potential severe weather conditions;
- monitor the direction, speed, and changes in potential severe weather patterns;
- provide public information on weather conditions several times per day;
- map snow and ice conditions for use in navigation and prediction of hydrologic conditions;
- provide direct read out foreign access to satellite weather data; and
- relay locally sampled environmental data from remote locations to central processing.

These data are then used, primarily by Government agencies, to issue advisories and warnings, to predict areas of potential storm impact, to advise mariners to prepare for excess or limited water storage conditions, and to measure local events through data relay against the synoptic conditions reported by satellite. There also appears to be a growing demand for the commercial use of these data for public information and tailored interpretation.

LANDSAT data has lagged behind meteorological information in its contribution to public welfare and health. However, limited use of LANDSAT has been made to determine and verify snow pack for water management, to assess the nature and extent of flood or other catastrophic damages, to monitor forest and crop diseases, and to measure the concentration and movement of pollutants. Other uses that await full exploitation include such activities as monitoring dessertification, improved forecasting of global food production, use of data derived from these activities for population and development statistics/predictions, and regional environmental baseline-impact assessments. Higher resolution, better absolute positioning, and other advances that can be implemented relatively quickly on an operational basis would expand these benefits substantially.

Perhaps the most exciting potentials for increased public and commercial benefits in the future lie in the combination of these systems and data products into a unified operational system of environmental information and services. One key to increased benefits is the application of additional resources to the delivery sub-systems; the key to obtaining these resources is the balanced involvement of and contributions made by commercial users.

(b) To what extent are State and Local governments utilizing this data for public services?

State and local Governments are active users of meteorological data provided by the Federal Government, most often to activate and guide the delivery of warning and emergency services. They also regularly use these data for inputs into their increasing responsibilities for health (e.g. crop spraying) and environmental (e.g. air emission) regulation.

State and local Government use of LANDSAT data has grown over the past several years, but apparently has evolved slowly due to the costs of purchasing processing equipment, uncertainty concerning continuity of data, and the expected lag in technology transfer. Public service applications we are aware of include state land use planning, resource inventory and monitoring, and water resource planning.

(c) What are the primary concerns of the state governments (i) with the system as it would be if LANDSAT D (and then D') were run by NOAA as they are now running LANDSAT 2 and 3? (ii) with the future commercialization of land remote sensing?

While this question could be answered best by the States, we understand their concerns, with respect to future LANDSAT use, are the quality and timeliness of the data and its cost. We understand these concerns apply to either a scenario of a Government operated system or a private sector owned and operated system.

(6) There is a fundamental question concerning centralized versus distributed data receipt and handling. Any legislation or policy should allow the most beneficial mode to develop.

(a) Is present data receipt and handling centralized? What are the advantages and disadvantages?

Current systems cannot achieve a market balanced centralized versus distributed system design because many of the decisions governing these choices are determined by several operating institutions. Thus, present systems are necessarily inefficient and higher priced because there are multiple satellite control centers, data acquisition networks, processing, distribution and archival systems.

Research and development goals may be best served by such an arrangement, but cost effective operational aims are not possible with this approach.

COMSAT has acknowledged strengths in data management and distribution, and we believe that a successful system will have both centralized and distributed data systems determined not by legislation but by market development and operational economics.

The centralized part of the system should be based on economic and system efficiency factors, and our proposed consolidation of control centers, data acquisition stations, and standard product processing and distribution systems reflects this approach. Value added services will be provided by highly specialized and widely scattered industries and, as such, ~~will~~ form a necessarily distributed data handling and user oriented service organization.

> (b) Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

A new system will evolve, after commercialization, that will achieve a balance between centralized and distributed data receipt and handling based on market development responses. The benefits of such a balanced system are reduced costs for system operations, more efficient and user responsive data collection and distribution networks, and better data products leading to increased sales as a result of a natural market development. The Government will continue to be a major customer and will continue to influence market evolution through this and the Government R&D development activities already discussed. With proper Government controls and continued participation, there are few, if any, disadvantages associated with this natural approach to system improvement.

(7) There is a need to clarify how remote sensing data could or should be priced.

(a) For a government-operated system should there be a pricing structure? For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

Price structures for Government operated systems data products exist today. The structures generally are designed to cover the costs of reproducing data delivered to users. Most observers agree, however, that even this objective is not being achieved. In some cases, the structures are designed to offer popular products at virtually no cost (e.g., LANDSAT standard photo reproductions). In other cases, such as the direct readout of imagery, there may be no costs associated with receipt (as with GOES and NOAA) or the costs are not associated with the quantity or potential value of products to the recipient (as in the LANDSAT foreign receive station agreements). None of the Government operated price structures attempt to recover the full costs of end-to-end system investment and operation.

Prices should reflect the value of delivering data that is time-perishible as well as the costs associated with the improvements needed in delivery sub-systems. Even though users often complain of delays or uncertainties in data delivery from current systems, pricing incentives or premiums have not been established to overcome this problem. There simply has not been a "market environment" to provide incentives to either provider or recipient to change system capabilities to meet demand signals. Instead, standard, heavily subsidized, and stable prices often are perceived by users as "rights" and improved services at the same prices as "obligations".

Pricing structures must undergo a thorough review rather than the marginal changes in prices suggested by charging different prices for different spectral bands. One key to a revised price structure is to develop products that are attractive to commercial, as well as, public users. Operational systems and services should be designed to achieve the highest value for the least investment. Various users should pay different prices for variations in product packages and service delivery. To the extent consistent with overriding public benefits, prices should be matched to value of service, prior commitments to buy, quantity of products purchased, and other market associated criteria. Provision should be made, if necessary, to underwrite explicit product and service prices that are necessary to achieve defined public benefits.

We believe a pricing structure should be built upon a consolidation of satellite systems and services, a declining proportion of governmental purchase commitments of system products over time, and variable pricing based upon such factors as the maturity of market demand, revision of direct receive arrangements, commercial use of Data Collection Systems, and bonafide market promotion.

(b) If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware development?

If the Government is going to own and operate satellite systems, it should recover the full costs of operational systems. It seems clear that full cost recovery will require changes in pricing policy, price rises for all users, and major market development, product planning, and sales efforts. Research and development costs should not initially be recovered by product and service sales. In the future, however, it appears clear that the cost of applied research, oriented to commercial utilization, must be recovered.

(c) For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

Since the Government will be a major market segment of near term private system initiatives, it should have a major role in establishing prices for Government products and services. These pricing arrangements need not be established by rulemaking, but should result from contract negotiations. For products and services that meet other than Government needs, we would anticipate negotiation of the principles governing the terms and conditions of product offerings.

(8) The following questions do not have to be considered LANDSAT specific, but can be viewed as pertaining to remote sensing from space in general.

(a) Do you feel that the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

At present, the necessary emphasis on and investment in remote sensing does not exist and advantages once held by the United States are being lost to other nations. Our position is exemplified by foreign exploitation of technologies developed by the U.S. (i.e., the French SPOT Program), the possible demise of the LANDSAT program, and a reduction in remote sensor missions and R&D. Government space program planning based on a comprehensive goal oriented plan with the kind of continuity required to implement such a plan has been absent from administrative policies since the Apollo experience.

This situation could have frightening consequences when one considers that space is as much a frontier as trans-oceanic exploration and exploitation were in the fifteenth century. Our country's socio/political and socio/economic eminence will surely be tied to space activities in the decades to come.

> (b) How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Establishment of commercially viable space systems have not progressed much beyond the highly successful communications industry entry into space more than a decade ago. The fundamental Government policies necessary for a successful remote sensing commercialization are not so much undefined as lacking in the primary intent to take this step. Postponing an immediate decision through a gradual transition or a program heavily regulated, controlled, and administered by the Federal Government will result in even less favorable circumstances by 1990.

What is needed is a firm resolve to establish a commercial remote sensing entity. This step will result in renewed growth and activity in space sustained by private sector investment and market development.

Mr. FLIPPO. Thank you very much.

Senator Schmitt?

Senator SCHMITT. Thank you, Mr. Chairman.

Gentlemen, would you each briefly comment on the breakdown that I suggested yesterday for the different components that would be involved in an Earth resources system? And I am not excluding meteorology for the purposes of discussion. I don't think it makes that much of a difference.

The three components I suggested were: a component of research and technology, a component of the provision of raw and/or preprocessed data, and a component of value-added data. Do you agree that is a reasonable breakdown of the field that we are talking about?

Mike?

Dr. HALBOUTY. I think it is, Senator.

Mr. ROSENBERG. Yes, it seems reasonable.

Dr. CHARYK. I think so.

Senator SCHMITT. Then, with respect to that, Mike, it is my feeling that you would like to see at least a temporary continuation, if not a permanent continuation of the research and technology effort in the Federal Government, NASA?

Dr. HALBOUTY. Yes.

Senator SCHMITT. Would you like to see at least a temporary continuation of NASA as the provider of preprocessed data, raw and preprocessed data, and you would expect the private sector to be the principal entity providing value-added data; is that correct?

Dr. HALBOUTY. Yes.

Senator SCHMITT. Now, Mr. Rosenberg, if I understand your testimony, the only modification of that is that you are not sure that the private sector ever would move into the raw and preprocessed data area?

Mr. ROSENBERG. My comments were relevant to ownership of the total system. I think that the investment involved in terms of the satellites, that is, the spacecraft themselves and the sensors; the ground stations; and the data processing complex is so very, very large for such an unknown market that a very high risk would be incurred. I think it would be wrong for the Government to subsidize that kind of investment.

On the other hand, there has been a lag in the utilization of the data, and in the investment for the extraction of useful information from that data by private industry and by the user community. I think these limitations have arisen because of the lack of a feeling that continuity of data has been assured.

Senator SCHMITT. And then, Mr. Charyk, your position shifts. Everybody is agreed, I think R. & D. ought to be in the Federal sector, advanced R. & D. Obviously, any private organization worth their salt would continue to do short-term and maybe some long-term work there. But your feeling is that both the provision of raw and preprocessed data and the provision of value-added data can be soundly based within the private sector?

Dr. CHARYK. Yes. The concept here would be that the designated entity would have the responsibility to produce edited, formated, and calibrated raw data.

The exploitation of that data would be available to all interested parties. The responsibilities for the designated entity would carry through, the editing, formating, and calibration of raw data. But I would imagine that there would be many parties who would be interested in taking that raw data, and processing it in different ways.

Senator SCHMITT. As there are today?

Dr. CHARYK. Yes. And providing value-added services. That would be clearly, we feel, a field which would be very active and would have many participants.

Senator SCHMITT. Would you expect to see Comsat generally involved in that value-added data? And if so, would there have to be some protections to avoid cross-subsidies?

Dr. CHARYK. There would clearly have to be protection to make sure that somehow——

Senator SCHMITT. Fully separated affiliate or something.

Dr. CHARYK. There would have to be some provisions made so that there wouldn't be, let's say, a built-in advantage to the collector of the data in providing value-added services.

The elements of the collecting system would, of course, be procured on a competitive basis. In other words, we would be looking for the best ideas in the industry as to the kinds of sensors, how they could be combined in the right kinds of payloads while at the same time looking at the marketplace and the economies of the total operation.

Senator SCHMITT. Now, Mr. Halbouty, do you feel very strongly that there should be no guarantees or subsidies in this program?

Dr. HALBOUTY. Absolutely.

Senator SCHMITT. Of any kind?

Dr. HALBOUTY. If industry takes it over, yes.

Senator SCHMITT. But you would not include in that circumstances where the Government provides some assistance to research institutions or other entities in order to get off the ground in the use of this information or something like that? The startup moneys and things like that, as we do today, you don't consider that a subsidy, I presume?

Dr. HALBOUTY. No, I don't. In that respect, provided that NASA takes it over, and whatever the relationship with the industry and Government would be in one agency, and that agency works with industry in whatever manner possible in order to insure the success of the program.

Senator SCHMITT. You would not consider that the use of the Department of Agriculture data on a continuing basis to provide crop forecasts would be in that sense a form of subsidy to the agricultural industry?

Dr. HALBOUTY. No, I don't.

Senator SCHMITT. Now, Mr. Charyk, finally, on this round of questioning, do you see the need for guarantees in subsidies other than, as I understand it, Comsat would like as a designated entity, to be the supplier of information for a fee to the Federal Government; is that correct?

Dr. CHARYK. We would assume the Government would enter into a contract for the services that the Government desired. And we are convinced that we could provide those services at substantial savings from what the Government is spending today for similar services.

Senator SCHMITT. Now, is the inclusion of meteorological data essential to that judgment?

Dr. CHARYK. We think it is essential to include meteorological data that because the meteorological system is truly in an operational stage, whereas the Landsat is still on the borderline. There is obviously an awful lot of work required for the development of that system.

We doubt that the Landsat could stand on its own feet on this kind of a proposal.

Senator SCHMITT. Ever?

Dr. CHARYK. Not ever. But we think that through the mechanism of producing a single Earth environmental system, the greatest impetus can be given to the development of the marketplace for Landsat-type products.

Senator SCHMITT. Would you consider taking over the Eros Data Center as part of the operational aspects of this system?

Dr. CHARYK. We are convinced, as I indicated in my testimony, that there are many duplicative facilities. And through the combining of these facilities and through an improvement in the efficiency of the operation, we think we can achieve savings of a very substantial nature. That, in turn, would permit us to offer those services to the Government that it needs at far less cost than the Government pays today for those services. In addition, then, we would have a real incentive to develop the commercial market because the economic viability of the total enterprise would depend upon the success in developing that commercial market.

Senator SCHMITT. Thank you.

Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Charyk, your testimony is very interesting. I'm interested in pursuing this savings to the Government that you talk about a little bit. You said that you thought the proposal would reduce Federal expenditure of several hundred million dollars. Does anyone know what the budget of NOAA and NESS is?

I wonder how much the Federal Government is spending in this area now. Perhaps we can get that for the record.

You mentioned savings through elimination of duplicative equipment. Is this analogous to, say, a post office? We have duplicate post offices all over the United States, but no one is saying we need one central post office.

Senator SCHMITT. It has certainly been said in my State, Mr. Chairman.

Mr. FLIPPO. You want to eliminate all the post offices?

Senator SCHMITT. It certainly looks that way to me. They eliminate service simultaneously so I guess it doesn't make any difference.

Mr. FLIPPO. I am just curious; the duplicative equipment may be related to service, may it not?

Dr. CHARYK. That's right. But if you have duplicative facilities, which I think are traceable to the fact that NASA has had the responsibility for one program and NOAA the responsibility for the others. Even within NOAA, there is a different arrangement for GOES than there is for the low altitude system.

We are simply saying that if you combine these in the most appropriate fashion, use the most efficient equipment, use common people to service those facilities, we believe substantial savings can be accomplished.

Mr. FLIPPO. Then, it is your feeling we have excess capacity; it is the excess capacity that can be reduced that can result in savings rather than perhaps reduce services.

Dr. CHARYK. Excess manpower and excess facilities. In other words, you can do the job with fewer properly selected facilities and fewer people, certainly.

Mr. FLIPPO. I think it would be extremely helpful if we had some better idea about your views of what excess equipment exists. That would help a great deal, I think.

Also, you make an interesting comparison of Comsat's origin, analogy between the present situation in remote sensing to the original formation of Comsat, communications industry. I would like to explore that just briefly.

Is that really a good analogy? Wasn't the private sector, the commercial market, already there, A.T. & T.? I believe you testified that within 2 years, A.T. & T. had some 60 circuits; that you looked to them already. Everyone already had a phone and was used to paying telephone bills. Isn't it true that market was already developed, and retail was well in hand?

Is that a good analogy, then, or perhaps you could elaborate.

Dr. CHARYK. I think it is a good analogy in the sense that the role of satellites in providing acceptable communication services was really not established. It was not clear what kind of satellite system could be utilized, if *any* satellite system could be utilized, and be competitive.

It also should be recognized that in that timeframe, high quality telephone communications existed only on a very limited basis. The first trans-Atlantic telephone cable had only been laid in the late fifties. Some high-quality telephone communications existed only between the major countries.

What was involved to improve telecommunications capabilities worldwide, was to focus on satellites as giving the promise of being a vehicle which could provide high quality telecommunication services worldwide. The key question was whether a system could be developed and whether that system could provide the quality of service with the economics that would make it attractive and that could be utilized so as to bring high-quality communication service to the rest of the world.

That has turned out, I believe, to be eminently successful. One hundred and six countries are now participants in the Intelsat system which is the system that we pioneered in the early days. It is a system in which the U.S. party is a private entity. It is a system to which 106 countries contribute R. & D. money, the costs of launching the satellites, all the operational costs, and in which we have no financial delinquents.

I think that it is a remarkable example in international cooperation. I probably shouldn't dwell on this too much, but the majority of the funds have been spent in the United States. The basis has been one of international competition for the facilities. We insisted at the outset that this selection be on the basis of the best equipment at the best price.

We would propose the same thing here, that is we would solicit the best that industry has to offer in the kinds of equipment that would be utilized in the system. The concept would be to develop a system which is best suited to meet the needs of the Government and commercial users, not only in this country, but worldwide, to develop the participating relationships with other countries as we have developed them in conjunction with the telecommunications business.

We think that that, through the designation of an entity, and the statement of a U.S. policy, the United States can move out and take a leadership role in how these services are developed and implemented and marketed worldwide.

And I think we would find a cooperative attitude on the part of countries throughout the world in working together toward that objective.

Mr. **Flippo**. Mr. McGrath.

Mr. **McGrath**. Thank you, Mr. Chairman.

I find this panel to be extremely interesting. It seems to be coming from different corners of the room. About the only thing we agree on, I guess, is that we need a continued availability of data.

I'm interested in Comsat's proposal. And I am particularly interested in whether or not they envision any exclusive rights or copyright or any monopolistic features that would be necessary in order to practically participate in this venture.

Dr. **Charyk**. Let me answer the question this way: We would certainly anticipate that we would be able to negotiate a contract with the Government where the Government would be satisfied that it was getting services at a lower price than it is paying for those services today.

Obviously, there would have to be limitations on what the Government would do with the data that it procured because part of the story here would be to develop a private market. Obviously, this could not be done if the Government turned around and gave all of the information for free to all interested parties.

So there would have to be restrictions that would be worked out as to the utilization of the data by the Government. Clearly, the Government would have no restrictions on use for its own purposes. But we would certainly not contemplate that the Government would destroy the potential private marketplace by making the data available to parties outside the Government.

Mr. **McGrath**. Sometimes, that is awfully hazy. If it is in the national interest, it might be in the State interest, too.

Dr. **Charyk**. It is hazy. You may well have to talk about copyright provisions to insure that there is protection of the data so that there is a private market preserve.

Mr. **McGrath**. How about sole-source procurement of this particular contract?

Dr. **Charyk**. We would be talking about putting up a system to meet the Government and the private needs. And we would, of course, procure that system on a competitive basis.

As far as the Government is concerned, it would, of course, be dealing with the designated entity in the negotiation of a contract to meet the Government needs. And the assumption clearly would have to be that the Government is able to procure the desired services under better terms and conditions than now exist. Otherwise, there would be no incentive to the Government to enter into such arrangement.

Mr. McGRATH. Let's say Comsat is going to certainly need two facilities and ground stations and computers, and GE manufactures satellites and ground stations, and they have computers. I'm wondering whether there would be any competition among even the two entities on the panel today if the Government decided to go this direction.

Would GE be interested in becoming——

Dr. CHARYK. I would assume GE would certainly be interested in providing some of the hardware for the system.

Mr. ROSENBERG. I could say unequivocally that we would be very happy to provide the spacecraft and the ground systems and the people to operate and maintain them. However, in order to undertake it as a private venture, I really think the investment portion of it is so great, that I would be hard pressed to recommend to our higher level management that they make that type of investment. This has been part of the thrust of my testimony.

And, with all due respect, I do feel there is a major difference between the communication business and the land remote sensing business. The communication business has an established user market and is a provision of service. The land remote sensing is a product market, the extent of which has not really been determined.

In one case, there is an existing market that could be built upon. But one is a service market; the other is a product market. And I say that they are very, very different.

Mr. McGRATH. Let me try to establish a short scenario here for Comsat. Comsat would come in and propose to buy existing satellites, existing ground stations. All of those in particular in the program now, or are you going to select them, as you said, to eliminate duplication? Would you buy what is particularly in the system now?

And if so, how would you come up with an assets value for those facilities?

Dr. CHARYK. An evaluation would have to be made of the facilities that would be procured.

Mr. McGRATH. First of all, would you buy them all?

Dr. CHARYK. I think you would have to look at the total list of facilities and decide which elements made sense to procure and which were duplicative. I would see no point in buying duplicative facilities.

Mr. McGRATH. If the Government decided perhaps some of the services you feel were duplicative were important, would that be a consideration?

Dr. CHARYK. I assume if the Government were willing to pay for the duplicative services and duplicative equipment, it would pose no problem. But that seems to me to destroy the purpose of the proposal, which is to try to develop the best system and operate in the most economical fashion.

Mr. McGrath. So we have established the fact that you are willing to buy equipment from the Government that already exists, and we haven't discussed how we are going to assess the value of that.

Do you think that it ought to be GAO or General Services or somebody like that comes up with an independent assessment? Or would you feel that it would be an outsider, an outside interest, coming in, particularly with an expertise in the field to come up with something? How would you envision that?

Dr. Charyk. I would envision in the first instance, the Government would estimate the value of the equipment that was being considered; and we would also estimate based on what is available the value to us of the equipment involved.

I would hope that there would not be a great divergence and that through discussion and negotiation process we could arrive at an agreeable price.

If there were a wide divergence on the estimated value of a particular item, I suspect one could consider utilizing a third party, objective third party, which could look at the arguments on both sides and provide an input as to what would be appropriate.

Mr. McGrath. Have you projected any percentage of return that would be necessary in order for Comsat to make a decent profit on this?

Dr. Charyk. We would imagine that we would have to make significant progress in developing a commercial market in order to make an acceptable return. In other words, since the Government would be utilizing only a portion of the capacity of the system, clearly, there would be a requirement for us to gain additional revenues from the development of the private marketplace. Our ability to make a profit would depend upon the development of that private marketplace.

Mr. McGrath. I have no more questions.

Mr. Flippo. Mr. Fuqua?

Mr. Fuqua. Mr. Halbouty and Mr. Rosenberg, I gather from your testimony that you indicate that the market is not there to sustain a system under private ownership at this time. Is that true?

Dr. Halbouty. I don't think so right now. When Comsat reaches a point where it is not making any money, what is going to happen to the integrity and preservation of the system? This concerns me very much.

Mr. Fuqua. If they should not make money?

Dr. Halbouty. If they should not make money. They are in the business of making money. When the financial risk reaches a point where they are not making money, something is going to happen to the system.

In other words, it is either going to dissolve, die, or they are going to give it back to the Government.

Mr. Fuqua. It is my understanding that the Government would subsidize or through purchase back of the data would try to keep the system afloat.

Dr. Halbouty. I disapprove of that. I don't think the Government should guarantee anything. I think if Comsat wants to take it over, let them guarantee to the Government they will spend everything for R. & D., everything that is necessary to keep the system alive. And they will take it away from the Government so the Government will have no further expenditure whatsoever.

Mr. FUQUA. Mr. Rosenberg?

Mr. ROSENBERG. In answer to the first part of your question about the market—the Government today constitutes about half of that market. I think some of the agencies that are using the data are probably being subsidized in one way or another or not paying the full costs of the acquisition of that data.

And at the same time, as I understand it, many of them have duplicative means of gathering data, although not as effectively. I think that if there is going to be a market that is 50 percent Government, the agencies are going to have to budget the right price for that data. If they are in a limited budget situation, they are going to have to take money away from other programs or from other things. The private sector market, I think, has really not been developed or understood.

Beyond that, we have agreements with some of our international friends who have put into place some ground stations. Our Government is now turning on the satellite for them and giving them the data so that they can process it. I would think any private enterprise that was in the land remote sensing business would want to get reimbursed for that.

I don't understand exactly how we would handle those prior agreements with our international friends. So there are a lot of questions that are raised in my mind about any proposition as to how this market would develop and how it could be maintained.

Dr. HALBOUTY. Right now, I don't think the industry would be able to survive in the present market.

Dr. CHARYK. If I may inject, Mr. Chairman, we are not asking for a subsidy from the Government. We are simply saying that an essential element of this signal would be that the Government would agree to procure its services through a contractual arrangement. The Government would pay if it got the quality of service that it needed and got it on a continuing basis.

You can always develop a scenario for disaster, but I would like to view this as an optimistic scenario. We believe there is a market. I don't like to start out with the idea we are automatically going to fail and the Government isn't going to be able to get its services.

Mr. FLIPPO. Mr. Charyk, excuse me just one moment. We are going to have to go vote and, we are running out of time. We will ask Senator Schmitt to continue the hearing, and we will try to return as soon as we can.

But in the event we don't, will you conclude?

Senator SCHMITT [presiding]. Yes. Thank you, Mr. Chairman. Did everybody get to say what they wanted to say in answer to that?

Dr. HALBOUTY. Well, I would like to say something to what he said.

Senator SCHMITT. Mr. Charyk was interrupted. Did you complete your statement?

Dr. CHARYK. I think for the moment, yes.

Senator SCHMITT. Go ahead.

Dr. HALBOUTY. Senator, you know, I think it is too early now to even think about industry taking over, especially by monopoly. I think if we are going to do something with industry, it should be done on a competitive basis.

There are a lot of companies out there still interested in the space program. I don't want to mention names, but there are dozens of them that will be able to serve the program and the project in many ways. And I feel like if the Government ever is going to go and give it to industry, they ought to give it to industry on the basis of a competitiveness, not to say that one entity is going to take it over.

In all due respect, I recognize Comsat's ability, and I think it is a wonderful organization. And it has done this country and itself a great deal of good. But still, at the same time, I don't think in this space Landsat program that we ought to give it to a particular monopoly.

I think that the industries out there, the small companies that would be able to preserve the space program by doing their own research, by doing a lot of input, which will probably in the long run serve the whole project much better.

Senator SCHMITT. Well, Mike, if I may interrupt, that is the reason I tried to establish that division. What you are saying certainly does apply to the value-added industry, and I don't think what Comsat has proposed is to in any way take over the value-added industry.

Now, let me ask you to focus on the specific question of competition within the provision of raw and preprocessed data. What about the raw material you need for that value-added industry to operate?

Dr. HALBOUTY. Well, I still think on the high-risk project NASA should conduct them. And I think on the low-risk project industry should conduct them.

Senator SCHMITT. But there is an intermediate ground here. There is a high-risk research and development or technology effort which everybody agrees NASA should continue to pursue. There is a low risk because there is a competitive industry out there of value-added information. There is the connector between the two. And that is the issue that you, Comsat, say the risk is low enough that we are willing to make a proposal to the Federal Government.

And I get the impression both you and Mr. Rosenberg think that the risk is too high and, therefore, the Federal Government should continue, at least for the foreseeable future, as the monopoly entity rather than having a commercial designee. Is that a summary of your impression?

Dr. HALBOUTY. Yes.

Mr. ROSENBERG. There is one other point I might add, and that concerns public service. You spoke yourself about the data on the Russian wheat crop being made available. I don't know how a private entity would provide that service—certainly not free of charge. It is in the public domain. It is information that I think our Government needs to know, and might want to make available to the public. Yet, if the private sector were to take the initiative in acquiring that kind of data, it would have no way to establish a proper price-value relationship, and no way to reap rewards commensurate with such service.

Senator SCHMITT. Well, I will let Joe answer that, if you would, because I don't think that there is anything incompatible in the designated entity proposal. I'm not an advocate one way or the other right now. But I don't think there is anything incompatible with the Agriculture Department getting the data they need in order to provide that forecasting system to the private sector.

Dr. CHARYK. Exactly.

Senator SCHMITT. Or at least insure that is not incompatible.

Now, you mentioned the copyright issue. I think we have to add to that the patent issue. Do any of you have any immediate comments right now? We certainly would solicit your thoughts for the record on that—how we do in fact deal with the problem of information being provided and distributed by secondary entities.

Joe, you made some comments.

Dr. CHARYK. I think that clearly if one is going to develop the private marketplace, there has got to be some restrictions on what one customer, in particular, the U.S. Government, might do with the data. Otherwise, it could destroy the potential market.

So there is going to have to be some protection that the data product is used by the customer for his purposes and is not made available under improper conditions to some other parties.

Accordingly, we need protection for the preservation of the marketplace.

Senator SCHMITT. For direct broadcast satellite you have an encoded cryptic signal going to a user. I think that is your proposal. What if the user pulls off that signal and starts to market it? Are you adequately protected? It is the same situation?

Dr. CHARYK. It is a similar situation. In our approach at the moment, we think our encrypting capability is going to be good enough so that the few people who are going to be able to solve that problem are not going to represent a significant economic deprivation to us.

Senator SCHMITT. You mean it would apply to the specific set once the person has paid his bills and gets his encrypted information?

Dr. CHARYK. We will have many codes, and these codes can be changed as frequently as necessary. They can be changed via a signal through the satellite. We think that is a sufficiently sophisticated system that the danger of improper utilization is minimal.

Senator SCHMITT. So the best way to do that is, what you are saying, back to the remote sensing situation, if some user begins to violate the basic contract you have with them, you just change the encryption.

Dr. CHARYK. No. What we are talking about here is the exploitation of the raw data. It is different in the sense, that we really don't have any control over that aspect.

We make the raw data available to any interested parties. What we need is some protection that the parties who now acquire the data from us do not exploit it in a way that would destroy the market for our basic product, that is, the raw data.

Senator SCHMITT. Well, I again don't see how you are going to do that without some kind of encryptive capability that you can change. Obviously, you can sign an agreement with the U.S. Government to see that that doesn't happen, but some other entity, foreign or otherwise, that is receiving your raw data can distribute that, of course, at your cost, whatever the customers pay for it.

Dr. **Charyk**. I think there would have to be an arrangement whereby the customers agree that the data is for their own use or for a defined use, in which case the defined use would determine the price. There would in turn clearly have to be some protection against the improper use of the information.

In other words, if the information is acquired for a specific purpose and priced accordingly, then its utilization has to be confined to that purpose.

Senator **Schmitt**. Mike, have you thought about the issue of nondiscriminatory distribution of data?

Dr. **Halbouty**. No, I haven't. I don't think there should be any discrimination on using the data. The thing that worries me now is that if the U.S. Government doesn't move beyond D-I, I don't know what is going to happen to our relationship that we have now in Japan and France and some of the other countries on the open-sky policy. And this thing bothers me.

I think as far as discrimination of data is concerned, it ought to be wide open. That is the reason why I recommended that the U.S. Government do whatever it possibly can as soon as possible to launch a Stereosat. You need to look ahead.

Senator **Schmitt**. Mr. Charyk, are there any significant lessons to be learned in our experience with Marisat here? You mentioned it in your testimony, but not in any great detail. Have international agreements been worked out on that basis that have relation to the kinds of international agreements that now exist for other data?

Dr. **Charyk**. I think there are some analogies in this sense. We began some years ago to look at the potential application of satellite communications to the maritime field. It was fairly clear that a well-defined market did not exist. Obviously, no commercial ship was equipped with a terminal that could utilize satellite communications. Nobody was about to put one on unless there was an appropriate satellite in orbit.

On the other hand, it was clear that a future market existed and had a great potential. No movement towards this potential could occur without an appropriate satellite.

Since the clock on satellite life starts with the launching of the satellite, since the satellite system is very expensive and since time is required to develop the commercial market, no economic justification for such an investment could be made.

Now, it so happened that at time the U.S. Navy was in need of services for its own purposes. We developed the concept that it might be possible to develop the commercial potential if we could provide in the earlier years service to the U.S. Navy. So we made a proposal whereby the Navy could lease a portion of the capacity of the satellite, so that then the commercial sector would have to bear only a fraction of the cost of the satellite.

This provided now an economically sound basis for the development of that commercial market. And today, we have more than 700 ships that are equipped. The Navy got the services that it needed on a far more economical basis than it could have by any other means, and so we think it was mutually beneficial.

The Navy got a better service on a timely basis at a lower cost than it could have had. At the same time, we have developed a commercial market which has great benefits to maritime shipping around the world and is a growing business.

I think this is an example of the kind of thing we contemplate here. Clearly, the major and dominant customer at the moment is the U.S. Government. You cannot put up a system for the private sector alone. Here is a vehicle where we can provide the Government needs at a lower cost and at the same time have a foundation from which we can develop the private market.

Senator **SCHMITT**. Are either of you other gentlemen familiar enough with Marisat to comment?

Mr. **ROSENBERG**. I am not.

Dr. **HALBOUTY**. No.

Senator **SCHMITT**. Well, but taking what Mr. Charyk has said at its face value, in a much more limited arena, similar kinds of transfer have been accomplished, and a commercial market is developing or has developed to the point where it carries its own weight.

Dr. **CHARYK**. It has led to the establishment of an international system with participation by a large number of countries. And stations to utilize the satellite are being built around the world. An international organization has been established. Both we and the U.S.S.R. are participants in that system. So we have evolved a truly international system which is going to provide on an economically sound basis commercial communications to the maritime fleets around the world.

Senator **SCHMITT**. Even without the U.S. Navy participation?

Dr. **CHARYK**. The Government utilization was essential to develop the commercial market, and provide the United States with a leadership role. We could have just sat back, and the Navy would not have had its service or would have done it some other way at much higher cost. The commercial market would not have developed.

But this was a vehicle through which there was a joint benefit. At the same time, the United States was able to exert some kind of a leadership in how this whole technology was evolved and utilized worldwide.

Senator **SCHMITT**. Given that kind of picture, do you see any place in that kind of application of that system?

Mr. **ROSENBERG**. I think the fundamental concept—that it requires Government market—is obviously true. And that similarity exists. I think that there may be less known about what the market is in the land remote sensing than there was in maritime communications.

That is only a guess on my part. I don't think we know what the user community, other than the Government would be.

Senator **SCHMITT**. I am frankly surprised at GE's perspective on that because they have been analyzing this market, at least they have in the past. I don't know what you have been doing recently. When you go to some meeting like the Pecora symposium at Sioux Falls or something like that, it is unbelievable what is going on in this field. To say that there are limits on that market, I think, Mike, you would agree, is just insane. There is none.

Mr. **Rosenberg**. I think potentially, it is a very, very large market. I think it has really not been assessed in terms of its total value. I think there is a tremendous potential value, but I don't think we could put a dollar and cents value on it today.

Senator **Schmitt**. Do you think we could do that on Comsat when it was first originated?

Mr. **Rosenberg**. I think there was a more developed market at that time.

Senator **Schmitt**. There obviously was, but I'm not sure we are very much removed right now in terms of the potential market after 17 years than we were, how many years ago?

Dr. **Charyk**. Comsat came into being in 1963, and we put up the first satellite in 1965.

To put the market in focus, the only customer as far as the United States was concerned that had any interest at all was A.T. & T., and for telephone purposes. A.T. & T. was troubled by Bell Labs' data. That suggested that synchronous satellites would be unsuitable for telephone communications. So they said, "We will lease 60 circuits on a tentative basis, and if they prove to be suitable, we will use them. We don't think they are likely to be too good because our data so suggests."

The interested parties, on the other hand, said, "Well, if A.T. & T. doesn't think they are going to be satisfactory, we are not interested in using them either." That was the estimate of the market at that time for synchronous satellites, not too attractive a prospect.

Senator **Schmitt**. Can you make a comparison of the risk now versus the risk then?

Dr. **Charyk**. I think the fields are really quite different, but what I'm saying is that in the communications field, satellite communications was a new mode but not a new thing. Here we have a more dubious situation.

Senator **Schmitt**. They are dubious when you start to try to put numbers on the actual market, but you wouldn't be sitting here today if you didn't think there——

Dr. **Charyk**. We believe there is enormous potential here. We can't quantify it, but we believe there is an enormous potential. We are willing to make a substantial financial bet that there is a commercial market.

We also submit the commercial market will not be developed without having as a foundation a Government understanding that it will procure services through a system that would be trying to develop the private marketplace at the same time as it is seeking to provide services to the Government.

Senator **Schmitt**. Thank you.

I will yield to Congressman Nelson.

Mr. **Nelson**. Let me just ask a couple questions of Dr. Charyk.

With the free exchange of weather data that we have in the international agreements, could Comsat meet this international set of commitments?

Dr. **Charyk**. Well, I think we would clearly have to honor such agreements as have been developed by the United States. And if in fact the United States has decided to provide at no cost certain kinds of data and certain kinds of services then we assume that this will be included in the commodity that the Government wants to buy and will be reflected in a price for that commodity.

Mr. NELSON. So you wouldn't charge for those kinds of services?

Dr. CHARYK. If the United States wants to acquire and pay for certain data and give it away free, would be its perogative.

Mr. NELSON. Let me ask you: you mentioned that you thought there was some excess equipment that through the present duplication you could combine——

Dr. CHARYK. Yes.

Mr. NELSON. [continuing.] And, therefore, make it more cost-effective. It is my understanding that in the processing of a lot of this data now, the equipment is so overloaded that it is running weeks behind. Where is that excess equipment that you are talking about?

Dr. CHARYK. I am not dealing just with the processing. As I indicated, what we are talking about here for the designated entity is simply the collection and the production of the raw product. We assume that the subsequent processing to put the data in a format for a variety of users will be on a competitive basis, and a lot of interested parties will be involved in that.

What I am primarily referring to are the facilities associated with controlling the satellites, maintaining the satellites in their proper attitudes, and the original readout of the data, not the subsequent processing of the data.

Mr. NELSON. You do see that subsequent processing as a problem right now?

Dr. CHARYK. We assume there will be a lot of people who will be interested in taking the raw product and processing it for a variety of applications. And we would be basically making the raw product available to all interested parties under similar terms and conditions.

Mr. NELSON. Thank you, Mr. Chairman.

Senator SCHMITT. Congressman McGrath.

Mr. MCGRATH. Thank you, Mr. Chairman.

Under the terms of your proposal, how would Comsat develop with our international agreements to provide data to other countries?

Dr. CHARYK. I think we would obviously have to evolve the appropriate agreements.

Mr. MCGRATH. Excuse me, sir. If that has already been answered, I just walked back in.

Dr. CHARYK. I might just give an analogy: the fact is that in telecommunications, for example, we had a leadership role in evolving an international agreement which governs the operation of the international system. Both the U.S. Government and our organization are signatories to that agreement.

It sets forth all of the aspects of how the system is operated, and both we and the Government, as I said, are signatories to that agreement.

Mr. MCGRATH. Let's talk about the marketability of the information. There has been testimony that 50 percent of the information as presently gathered goes toward a market which is free to the user. Putting into that equation the fact that we are soon to have competition from other nations, where is our market going to come from other than through perhaps the hidden subsidy of Government buying the information which they presently get for nothing?

Dr. CHARYK. In the first place, the Government is clearly the major customer for the Landsat-type data at the present time. I think Mr. Halbouty has indicated that it hasn't been possible to develop a private market simply because there is no assurance of any kind of continuity or that the right kind of data will be acquired and made available on a timely basis.

That is an essential element if you are going to develop a private market.

Mr. MCGRATH. Let's propose that as a given. We are going to do that. Now, where are we coming from?

Dr. CHARYK. I think the energy community is certainly an outstanding possibility as a user of the appropriate kind of product. Mr. Halbouty has clearly indicated some of the new kinds of technology that should be introduced and made available and I believe would be of great interest to the energy business.

There is also the agricultural business which I think has both a Government and a private component.

Mr. MCGRATH. We have testimony from Mr. Rosenberg, from GE, that there isn't a current marketplace, and for good reason, as you pointed out. To what degree have you studied the marketplace? Obviously, it is a favorable study or else you wouldn't be coming up with this proposal. I want to get the details of that study.

Dr. CHARYK. Obviously, as I said a few moments ago, it can't be quantified, but we see enough evidence of a potential commercial marketplace that we believe that with a proper Government policy, an appropriate dedication, and a determination by the Government, that it will buy its services from an integrated system; that there is a sufficiently attractive commercial market as that the total enterprise can become a profitable activity.

But it is a matter of hope. It is a calculated risk. It might not come to pass. It might come to pass in a somewhat longer timeframe. We may have losses, but we are willing to take that chance.

Mr. MCGRATH. I have no further questions, Mr. Chairman.

Senator SCHMITT. Thank you, Congressman.

Mike, you suggested the draft legislation, if enacted, would have insured little private sector interest. Would you be more specific what provisions you are particularly concerned about?

Dr. HALBOUTY. Well, I strongly feel that by adding another agency, all you do is confuse the issue a little more. And I don't think that industry would be interested to go ahead and continue its own studies to determine just how it could work with the Government. The more agencies you have, the more confusion you have. This has been my experience with the Government.

And as far as agencies are concerned, I think working with one agency is a lot better than working with three. And I think the Department of the Interior and NASA have done a superb job so far in the entire program. I don't think that NOAA is necessary. I think the operation can stay in NASA.

Senator SCHMITT. Mike, you and Mr. Rosenberg have a little bit of a disagreement, I think. Let me see if I can point it out.

You feel the reason for less than might be anticipated capital investment on the use of Earth resources information is the result of what Joe Charyk has just described as the lack of continuity and timeliness and certainty, whereas Mr. Rosenberg, if I understood your testimony correctly, thinks it is because the users are not fully convinced yet of its utility.

Is there a disagreement here or combination of both?

Mr. **Rosenberg**. I think it is a combination of both, or just coming at the same issue from different points of view. I don't think there is a wide diversity. The user community continuity issue is only one of several that has precluded their investment in the processing equipment and extract. I believe that is only one of the issues.

Senator **Schmitt**. Have either of you ever run into somebody that made a significant commitment to trying to use remote sensing information, backed away and said it was of no use?

Dr. **Halbouty**. No, I have never seen that in all of the experience I have had. And I have contacted many operators, and especially in the minerals and petroleum fields. And in every instance where an individual has used remote sensing to explore for energy or minerals, it has been successfully integrated with the geoscientific information.

Now, today, there are some companies even moving in the direction of trying to use Landsat data exclusively. What we have learned in the past with Landsat is that—the higher we go, the deeper we see.

And with Landsat 2 and 3 and those that will follow, we get more information each day. I think, Dr. Charyk, there is no question that in the future, more information will be obtained by the use of Landsat. We are innovating the use every day.

In the petroleum field, we are looking at things today that we never dreamed of 5 years ago. I think 5 years from now, we are going to be looking at things from the images that we don't even know exist today because of the new techniques and new equipment that will probably give us better interpretation of the images.

But we have gone so far now where there are certain companies, to get back to your question, where they use the Landsat data exclusively.

Senator **Schmitt**. A couple of years ago I was visiting Sioux Falls, I certainly was impressed by the remote sensing from the surface downward and potential for integrating the two systems and other sources of information to get an even broader synergistic picture than you can get just with Landsat. I think earlier you testified to this point.

But just to close this off, the more I think about it, the more I cannot remember a single instance of anybody testifying, telling me, private, public, or otherwise, that when they made a commitment to look at the use of remote sensing data from space or from aircraft or combinations of the two, that they backed away from it and said it was of no use and then terminated the commitment.

I can't think of a certain circumstance, which bodes well for the future of the market.

Dr. **Halbouty**. Neither can I. I agree 100 percent.

Mr. **McGrath**. Senator, I am going to leave you on your own. You are in a friendly environment.

Senator SCHMITT. We are just about to close this off. Thank you, Congressman. It is once again a pleasure to be with your subcommittee.

Finally, I guess, Joe, in the telecommunications area, after Comsat really developed the market, and it was obvious there was a market, other entities started to get into the communications satellite business on a competitive basis. And a competitive industry has really developed in spite of Comsat's special role and relationship to the U.S. Government.

Do you anticipate that that would happen in the Earth resources area and weather data area if your market terms are correct?

Dr. CHARYK. I think it could well happen down the road somewhere. The market would develop to the point where a variety of systems might make sense. But I think at this stage of the game, in my judgment, the only possibility to get on with the development would be a single, integrated system.

Because the economies of scale are so significant and so important to the development of this marketplace I can visualize no other way in whch we can move ahead with the same speed as we would be able to move ahead with in the case of an integrated system. But I think it is quite feasible that somewhere down the road, particularly if all of this optimism turns out to be correct, there could be a place for multiple systems. But that is a judgment which I think should be made further down the road.

Senator SCHMITT. Finally, and this is sort of an open question to all of you, if there were a designated entity generally under the type of system as described by Mr. Charyk, do you see any liability problems? Do you see any insurance problems, any problems with providing proprietary data, that might be collected either on an international sphere or on a private sphere?

This is sort of another murky area. Do you see anything there, Mike?

Dr. HALBOUTY. Yes. Reclassification of military data that we have today. In other words, the private sector really would like to have a lot of the information that the military has on Landsat. However, we all realize it is highly restricted. But still, it is information that may be very vital in exploring the globe, not just the United States.

Senator SCHMITT. Let me be a little more specific. In the oil and gas industry, do you see any reason why raw data, preprocessed data, should be proprietary? Is it the value-added data that only becomes proprietary?

Dr. HALBOUTY. I'm against any restriction on data. I think the data should be absolutely open for all use.

Senator SCHMITT. Do you think that is a view shared within the industry?

Dr. HALBOUTY. I think I share the view of industry in that regard which is my opinion.

Senator SCHMITT. Do you think Exxon or Mobil would agree that data provided from a raw, preprocessed basis by, say, a designated entity should be nondiscriminatory, that there should be no propreitary aspects to it, even if it was taken from leased time, by the company?

Dr. HALBOUTY. I think if Mr. Rosenberg wanted that same data, he ought to have the opportunity to buy it.

Mr. ROSENBERG. I pass on that.

Dr. CHARYK. I would be happy to sell it on a like basis.

Senator SCHMITT. You think generally, we should not provide for proprietary?

Mr. ROSENBERG. In general, of the raw data.

Senator SCHMITT. Now, what about liability? Do you think there is any liability attached to the raw, preprocessed data? Obviously, there might be if you were forecasting weather and you did it wrong, but that is a value-added.

Dr. CHARYK. That's right. We wouldn't be in the weather prediction business, but would simply be providing the raw data and the appropriate responsible people would be utilizing the data to do the forecasting.

Senator SCHMITT. What if you had a data dropout and could not provide that data that was necessary for value-added forecasting of tornadoes? Do you think you would be liable?

Dr. CHARYK. Well, I think that one of the——

Senator SCHMITT. That is the trouble with coming out of the space program; you always think of what if.

Dr. CHARYK. One of the important elements, though, is to design a system that has continuity and sufficient redundancy is to insure continuity. This is vital in telecommunications. If we were to have a major failure in our satellite system, the results could be catastrophic. You could destroy telecommunications to countless nations.

Interestingly enough, the reliability of the system is better than 99.95 percent, and we have adequate redundancy so that if the dropouts do occur, they are of quite short duration and quite acceptable.

Senator SCHMITT. You have no litigation?

Dr. CHARYK. We have no litigation.

Senator SCHMITT. Under those circumstances, do you foresee any other weather data markets other than the Federal Government and the world weather organization?

Dr. CHARYK. We believe that there is a potential private marketplace for certain kinds of meteorological data, yes.

Senator SCHMITT. In the private sector, you mean outside of Government?

Dr. CHARYK. Yes; but a limited one.

Senator SCHMITT. Does that include oceanographic data?

Dr. CHARYK. We would think we are talking here about sea as well as Earth data.

Senator SCHMITT. I see. What about ship data?

Dr. CHARYK. For example, one area that has direct commercial application even today is ship routing. In other words, providing information to shipowners on sea conditions and on meteorological conditions to best accomplish the transit of the ship from point A to point B.

There are many shipowners who buy this kind of service regularly and find it extremely useful in improving the efficiency of operations of the fleet.

Dr. Halbouty. I might add to that the petroleum industry, on all of the offshore operations, uses private meteorological services. They get as much information out of Government, but they don't trust Government. They go back and do their own work.

Senator Schmitt. Mike, you are damaging your case.

Dr. Halbouty. Well, I have to tell the truth.

Senator Schmitt. When you think meteorological, are you thinking of the broader term, climatic information?

Dr. Charyk. I think that probably is a more apt description.

Senator Schmitt. Wait a minute. By "climatic," I mean multiyear information as to solar activity, upper atmosphere activity, and so forth. Would you see that as part of this system also? Or is that still research?

Dr. Charyk. To the extent that the research and development provides the capability to include instruments that can provide information that is useful to the prediction of weather, to the prediction of climatic conditions, yes, we think they should be included.

But obviously, some things are still in the future. Some things are in the immediate potential, and some things are here. It is a matter of making sure that we get as much information as it is practical to acquire within the perfected state of the technology to provide data which has the greatest value to the user. I think the user is going to have a lot to say about the kind of developments that occur and the kind of sensors that are developed.

The name of the game here is to develop the private marketplace, and the desires and needs of the private customer are going to be very crucial as to how the system is planned and evolved.

Senator Schmitt. Gentlemen, I want to thank you.

We will probably think up some more questions for the record. It has been very fruitful. And sorry to keep you on the platform so long.

But I think it has been helpful to the committee to have this interaction. Thank you.

This set of hearings is adjourned.

[Whereupon, at 12 noon, the hearing was adjourned.]

APPENDIX

Additional Material Submitted for the Record

The Geosat Committee, Inc.

OPERATIONAL CIVIL LAND REMOTE SENSING SYSTEMS; AN ANALYSIS OF BACKGROUND QUESTIONS RAISED BY THE SENATE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE AND THE HOUSE SUBCOMMITTEE ON SPACE, SCIENCE AND APPLICATIONS FOR JOINT HEARINGS CONDUCTED 22-23 JULY 1981, WASHINGTON DC, PREPARED BY THE GEOSAT COMMITTEE, INC. 20 JULY 1981

The major questions raised by these joint hearings involve the operational aspects of civil land remote sensing satellite systems. The Geosat Committee, an international committee of 100 companies worldwide interested primarily in the improved development of global civil land remote sensing for exploration and engineering geological applications, has supported the development of private sector involvement in this area for some time but has been impaired in these efforts by the lack of institutional arrangements to encourage such involvement. The situation is further complicated by the fact that, among all these complex issues, an operational civil system must serve both private industry and government.

A principal question is if movement should be made immediately into an operational system or if an interim system would be of more benefit; here, the key issue is who controls the data. If the private sector controls any system, it must control all portions of that system, both in space and on the ground. One of the serious problems with this at present is the question of whether such a system could be economically developed; currently unlikely if we view the entire Landsat system. However, it is quite likely that portions of that system or other systems, such as a STEREOSAT-type section, could well be economically viable.

The question of government/industry joint ventures has been raised and it would seem that some sort of government/industry cooperation must exist in any transition period between a fully operational system and what is in existance now, a government R&D or quasi-operational system. It appears that unless we continue over the long term to examine what institutional framework must be developed or create legislation cooperatively with the current administration and those who will follow, we will never see any form of either government or private sector operational civil land remote sensing systems. It simply will not work without cooperative efforts being made between the administrative branch and the Congress to create a framework in which an orderly process of transfer to the private sector may take place. In this context, _if_ the government is to create an operational system over a period of time, such as was proposed under NOAA, then it should be under one agency in hopes of increasing the efficiency of the government side of operations. However, if the development of an operational system is institutionalized within government, it probably will never come out to the private sector. Thus it must be determined whether such an operational system should be private sector, government, or, in fact, a truly joint venture system in order that the natural evolution of such systems leads to an operable

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mechanism to accomplish the goals required by both government and industry in the U.S.

It is imperitive that a mechanism be created between the private sector and government to decide what is operational as well as when and how it should be made available to the private sector on an economical basis. There seems to be a difference of opinion on the definition of "operational", such as the Landsat program, and what is economically operational in the sense of private sector investment for a civil land remote sensing system. Because of this difference of opinion among many parties, an entity must be created between government and the private sector to make that determination.

Such an economic operational system must also be allowed to flourish within the realm of military satellite surveillance systems. In this context, there are issues which must be addressed either by legislation or administrative fiat as civil operational remote sensing systems probably will not evolve until this is done. Among these issues are 1) no civil land remote sensing system can operate in competition with Federally subsidized systems and/or data for the cost of reproduction without some cooperative venture. This is true whether it is the U.S. government or the French, Japanese or some other nation who might provide similar data at virtually no cost; 2) because of the Reagan Administration's decision to stop the LANDSAT D program at the end of D', it is imperative that any follow-on system operated by the private sector must have the approval, the endorsement, and the international protection of the U.S. government in dealing with all other signatories of past and present international space laws, data rights, and agreements of which the U.S. is part; 3) to any private sector investment effort, it is of paramount importance to fully understand whether or not any reclassification of military surveillance data would take place. The Geosat Committee has worked on this problem with the Carter Administration and is attempting to continue these efforts under the Reagan Administration. It is most important to clarify this issue once and for all before the annual deliberative processes of the OMB. A clear-cut government statement about the future release of non-release of these data is an important factor to the decisions of any group considering investment in an operational civil system.

The concept of a single agency responsibility for the R&D of operational systems with meaningful industry/government input to determine when such systems should go to the private sector is of great importance. The current confusion over the roles of NASA, NOAA and the EROS Data Center underline the confusion within the government as to future directions and, importantly, the lack of a comprehensive policy to address national remote sensing needs and associated issues. The uncoordinated agency roles and the lack of an institutional framework are detrimentally affecting both the growth and the utilization of remote sensing data as well as the planning for an operational system and are also a critical ingredient to the apparent turnover of U.S. developed satellite remote sensing systems to other countries. A significant factor in that aspect is that if the U.S. drops out of the Landsat program in the mid-80's with no policy or coordinated agency roles for private sector civil satellite remote sensing development for the U.S., it is possible that the French, Japanese and other systems may not cooperate in "Open Skies" accessibility and availability of global data to all users. If the U.S. is not a player at the table, it is possible the other players will not serve our data requirements equally.

The areas of participation and definition of private sector responsibilities to best serve the U.S. interests are not yet defined. There are no mechanisms yet to develop a cooperative effort between government and industry to define where such participation and responsibilities should lie. It is appalling that the U.S. has no mechanisms in this area. All other industrialized countries participating in satellite remote sensing development in the critical area of energy/mineral resource exploration have such mechanisms.

Regarding the questions raised on Page 2 of the Flippo-Schmitt letter of 29 June 1981 under "Issues", the designation of a lead agency is, of course, required; but if that lead agency does not speak for the entire aggregated government market end user groups, it will be insufficient. Clearly, an all-government policy framework must be developed, and developed soon. The Federal government and the private sector must form some workable mechanism to take care of both their needs. This could take the form of a joint venture, the private sector serving as a government contractor, or the Federal government service the private sector. It does seem to The Geosat Committee that much of the work done in this area can and should be moved to the private sector as the most efficient means of providing such data services, keeping the needs of the small user well in mind in such a transfer.

The government sector can best serve the national needs in providing data to both the public and the private sector by defining what those national needs are. This has not been done, at least for non-renewable resource global exploration. Remote sensing will provide useful data to other countries for their resource development through international cooperation. The need to provide international data must be considered in turning over civil land remote sensing systems to the private sector. These needs have not been defined for resource exploration.

The government is clearly the best equipped to conduct R&D in the technologically complex area of satellites. It is unlikely that such R&D would be done by the private sector due to the cost factor and unknown applications by governments and industry worldwide. If the operational system remains within government, technology transfer is most important; however, if an operational system is developed and transferred to the private sector it would seem that technology transfer would be a function of the private sector entities marketing development.

The government should guarantee data continuity if it remains the principal developer of civil land remote sensing systems. If these systems are transferred to the private sector, it would seem that the continuity issue would become a question of economics. In this case, in the interests of the U.S. the government should guarantee that some form of continuity is continued whether or not these systems are economic. Government has the international responsibility for control of the provision of such data and the rights to remotely sense other countries and must provide a guarantee that a government and/or private sector system will have continuity. Government should mandate that the private sector provide data under agreed-upon international relationships such as the "Open Skies" policy. However, with such a mandate it must also provide data security for the private sector under the present international space laws and agreements.

The question of whether legislation for government/industry joint ventures is needed or not must be answered by government as well as the private sector. It does not appear that new legislation is truly required for the development of a contractual relationship for an industry entity to provide services to government in this area. However, because it must oversee such a development, government must also guarantee international data rights of such a system in the best interests of the U.S.

The following comments are offered for the one-line questions included in the 29 June 1981 letter from Congressman Flippo and Senator Schmitt:

1. *The strategy for an institutional user community amalgamation is a difficult one at best in view of the lack of a government/industry institution with which to accomplish it. If a single agency is given the responsibility for developing an operational system, then that agency must have the authority and be responsible for the amalgamation of the government user community. Presumably, the private sector entity would amalgamate their user community through their marketing efforts. In the interim, The Geosat Committee has recommended a strong Advisory Board of industry and government users which MUST have the authority and responsibility as well as the funding to amalgamate the user community requirements in the national interest.*

2. *Sufficient industrial R&D in satellite remote sensing has not yet occurred to provide a sufficient technology or economic base for a fully operational Landsat system. Although the use of data from the Landsat system is rapidly approaching operational status throughout the user community, it will be some time before it is fully operational. This is a normal evolution for new technology. It takes time for it to be accepted by the field user.*

3. *Both government and the private sector are already planning for R&D in the potential use of an operational Landsat system. The initial R&D requirements should be within the government sector but as it evolves into an operational system it should go through a similar R&D phase, with emphasis on the development, within the private sector. Most companies interested in this area are presently in the development phase of the use of this system and are on the verge of going operational. It should be well understood that both the private sector and the government sector pay for an R&D use of such data. The initial R&D should probably remain with NASA.*

4. *The Geosat Committee cannot say how an operational system should be defined and focused for all users as we do not represent agriculture, hydrology, land use planning, etc. However, the remote sensing user community has to define its needs as we in The Geosat Committee have done for geology. These needs must then be further defined in spatial and spectral resolution as well as in repetitive coverage, data archival for future use, and other such issues.*

5. *We believe that the market has so developed and can provide an economical private sector owned/operated system for portions of our requirements, such as STEREOSAT. The Thematic Mapper, or portions thereof, could also rapidly develop a market and become an operational system. The total Landsat system, however, may not yet be economic at present to be supported solely by the private sector.*

6. *For those portions that are economic, the proper government/private sector relationship should be to move them to the private sector as the most efficient way of operating the systems. Those areas that are properly within government sectors and service, such as state and local governments, academia, etc., which cannot be provided economically should be retained within government. An interim period, perhaps as a joint venture type of arrangement, is probably the most prudent way over the next several years if we are ever to accomplish our goals before non-U.S. competition is a fact.*

7. *Non-profit organizations, such as universities, etc., must find their own role in an evolving private sector development for data because the costs will increase. If it is within the national interest to provide cheap data to these non-profit organizations, then it should fall within the purview of the Federal government. This, however, should not be directly competitive with any parallel private sector development.*

8. *Because of the costs of future civil land remote sensing systems the best course we could follow is to create complementary compatible systems. This would involve all interested countries in building cooperative data base systems, satellite systems and data distribution systems which would minimize cost and unnecessary duplication of data. Data acquisition and processing are costly ventures; accordingly, it would be in the best interests of the U.S., and of the world, if these evolving systems shared these data systems under the "Open Skies" concept and do not evolve into nationalistic, duplicative, competitive systems.*

9. *In the long run, the operator for an operational system should be the private sector in a cooperative mode with government. Those areas which cannot be economically provided by the private sector but are of national interest should be operated by the Federal system. It is important that a joint cooperative government/industry mechanism and/or Advisory Board is created to make these systems operate effectively and efficiently.*

10. *The proper mechanism for user input to decisions, whether these decisions be government, industry management, or joint venture, would be an Advisory Board which controls the decision which relate to all user segments as has been recommended by The Geosat Committee in the past.*

11. *Data continuity must be provided by policy and budget decisions to produce such systems. The current annual effort by the OMB to reduce these data systems must be stopped until the mechanisms are created for the data to be developed within the private sector. If not, the government policy is clearly shortsighted and not in the national interest.*

12. *Additive value free market competition can be assured if there is agreement between the government and the private sector as to how those data rights are to be protected. Competition between the Federal government and the private sector will occur if the government portion is done at cost of reproduction. It seems imperative that the value added market be in the hands of private ownership where it would be most efficient. The value added free market is a separate market and is not the same thing as providing basic "raw" data.*

13. *Equal access to data at reasonable cost can be maintained under private sector ownership but it should be recognized that those who are accustomed to data access at cost of reproduction may not be able to finance all the data they choose to use at such rates. The important point here is to define what is reasonable and economic. The private sector will provide data far more efficiently and it will provide it to a market that is willing to pay for it. The actual users and the loss of those who get data virtually free cannot be determined at this time, but is a real factor.*

Frederick B. Henderson III, Ph.D.
President, The Geosat Committee, Inc.

Frederick B. Henderson III

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DIRECTOR

July 31, 1981

Honorable Don Fuqua, Chairman
Committee on Science and Technology
U. S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20215

Dear Mr. Chairman:

Your letter of May 29, 1981 to Senator Ted Stevens, Chairman of the Technology Assessment Board, requested assistance from OTA in the form of written analysis on land remote sensing for hearings to be held by the Subcommittee on Space Science and Applications. Attached is a statement by Dr. Ray A. Williamson, Project Director in the OTA Space Program, discussing the criteria for an operational remote sensing system as seen from the standpoint of the user of remote sensing data.

The statement was prepared from material presented to OTA in two workshops that were held in May, 1981 as part of our Space Policy and Applications assessment. In addition, the assessment's Advisory Panel and other remote sensing users were polled for their opinions about the issues. This statement represents a portion of work in progress. As such, it has not been approved by the Technology Assessment Board.

I hope it will be helpful to your deliberations about an operational satellite remote sensing system.

Sincerely,

John Andelin
Assistant Director

RECEIVED

[illegible]

Statement of Dr. Ray A. Williamson
Space Program
Office of Technology Assessment
To the
Subcommittee on Space Science and Applications
of the Committee on Science and Technology
U.S. House of Representatives
July 23, 1981

OTA appreciates the opportunity to place this statement about the criteria for an operational remote sensing system in the record. The Office of Technology Assessment is currently working on a broad independent assessment of this Nation's civilian space policy and applications of technology in space. The study, which was requested by the parent committee of this subcommittee, analyzes the effects of past policies and presents the key issues that face the U.S. space program in planning for the future. It is developing policy alternatives that might be adopted to encourage timely and cost-effective applications of space technologies. The assessment is also exploring the appropriate roles of government and industry in operating space systems and in promoting commercialization of publicly-funded research and development. We are studying space remote sensing technology and policy as a major part of this larger assessment.

Because results from OTA's assessment are not yet available, this interim statement is restricted to a discussion of some of the issues which we have identified in the process of collecting data. OTA recently conducted two workshops on space remote sensing. The first investigated the needs and concerns of the local, state and federal government users of Landsat data. The second explored the potential for commercialization of land remote sensing from space, and compared possible models and mechanisms which might be used to accomplish it. This report is based upon what we learned from those two workshops, from the OTA Space Policy and Applications Advisory Panel, and from other experts in remote sensing issues. It therefore reflects the views of a broad spectrum of the civil community who use or are otherwise directly affected by federal decisions about space remote sensing technology.

The current status of the U.S. remote sensing satellite progam

Many users of civil satellite remote sensing data express considerable frustration with the current U.S. program. From their viewpoint, it is in disarray, and is characterized by a lack of clear direction and by organizational ambivalence. According to U.S. policy, as articulated in the November 1979 Presidential Directive 54, the National Oceanic and Atmospheric Administration (NOAA) is responsibile for the management of civil operational land remote sensing sensing activities. The National Aeronautics and Space Administration (NASA) remains in charge of the research and development of satellite remote sensing for the civil sector. NOAA is also charged with the task of seeking "ways to enhance private sector opportunities" in civil land remote sensing with the goal of "eventual operation by the private sector of our civil land remote sensing activities."

The reaction of the user community to commercializing remote sensing from space will be addressed later. For now, let us examine the needs of users and the major problems they face in their dependence on Landsat data. Many user problems relate to the fact that although it is U.S. policy to have an operational satellite remote sensing system, it is still being run by NASA as an R&D system. They will continue to do so until fiscal year 1983.

The data from Landsats 1, 2, and 3 have attracted a wide variety of users in this country and abroad. These users consider Landsat data to be an invaluable component of the larger realm of resource inventory data from all sources. For some, data from Landsat have become a baseline requirement of their daily routine. For others, these data serve the secondary, but important role of a comparison data-base. They all treat Landsat as if it were an operational system.

The users we polled identified a number of problems that the current arrangement has obliged them to face. Although their needs for, and use of, remote sensing data differ markedly, they agreed on the following requirements for an operational space remote sensing system.

Characteristics of a Viable Operational System (from the user point of view)

- Continuity of data flow. Reliable continuous flow of data is regarded by operational users as a mandatory condition.

For each user, the term "continuous data flow" has a slightly different meaning. However, it generally means being able to acquire the data that a satellite could have taken, or did take, in a timely manner appropriate to the given application.

In the past, the data flow has been interrupted or slowed by failure of the tape recorders on the satellites, a natural enough occurrence in an R&D system, but unacceptable in an operational one. Therefore, in order to ensure continuity, the users would prefer the most reliable possible system consistent with obtaining the needed data. A back-up satellite for deployment should the first satellite fail in a major way is also an important requirement. For example, users are disturbed that if Landsats 2 and 3 were to fail completely tomorrow, there could be no replacement until Landsat D is launched in the third quarter of 1982. Unfortunately, the launch of Landsat D cannot be accelerated in any significant way.

Delivery of data to the user has also been interrupted or slowed by the inability of the data center at NASA Goddard to process Landsat data fast enough. Users have experienced delays of up to 6 months in the delivery of Landsat data. Certain time-dependent data needs, such as those for agriculture or pollution control programs, cannot be served if the data cannot be processed within a few days (See Table 1, below). The work of other programs is also slowed considerably by such delays.

Continuity of data also means retaining data acquired in previous years. Landsat satellites have provided data since 1972, when the first satellite was launched. The users have been told that early data, which are currently being stored at Goddard, are scheduled for destruction. However, for many uses, these early observations represent a valuable and irreplaceable baseline for comparison with later observations. In addition, much of the only cloud-free global coverage dates from this early period in space remote sensing. Users agree that it is important to retain these early data and make them available upon request. They represent a large investment and a valuable global resource for the future.

Looking toward the future, the users of Landsat data are concerned that data will not have begun flowing from Landsat D before it ceases from Landsats 2 and 3. Will Landsat D be operational soon enough to assure continuity of the data flow? What plans are there for backup should it fail to operate as planned?

It is of more than casual interest to note that if continuity of the data flow is not maintained and the resulting hiatus continues beyond the time when the French SPOT system is operational, many U.S. users will certainly turn to the French to supply some of their data needs. This potential has continuing implications for the long-term future of U.S. remote sensing systems. If users begin to use SPOT data in any significant way, they may be reluctant to switch back to Landsat derived data.

- Quality and Integrity of data. It is important that data different time periods be comparable and of uniform quality.

Landsat data are initially "preprocessed" at Goddard; the results are in the form of High Density Digital Tapes (HDDTs). These HDDTS are then sent to the EROS Data Center for processing. EROS in turn supplies data to users either in the form of film imagery or Computer Compatible Tapes (CCTs). Some additional special processing of data to meet particular user needs is done at EROS; other similar processing is done by various value-added industries.

Three problems have surfaced in the data stream from satellite to user. First, the quality of data tapes is not always maintained at a high level. Users complain that errors introduced in the HDDTs from Goddard are passed through and appear in the CCTs from EROS. Second, abrupt changes over time in the format of CCTs have seriously inconvenienced users. These changes have made it impossible to process older CCTS with the techniques for processing current CCTs. Users must therefore go to unanticipated and sometimes extraordinary lengths to process the earlier tapes. These format changes were made without sufficiently consulting the needs of the user community. Third, not all users want to purchase preprocessed data because preprocessing necessarily causes some degradation of quality or loss of information. For some applications, it is better to have raw data as it comes off the spacecraft.

- Adequate consultation with the user community. This is an essential element of an operational space remote sensing system, whether operated by the federal government or by the private sector.

Although NASA consulted other federal agency users, neither the private sector nor the state and local government users have been included in any significant way in the key decision-making processes. A successful operational system depends on the full participation of all elements involved in the system.

In an effort to build interest in the capabilities of Landsat, NASA has previously sought the advice of the user community about its needs with respect to sensors and resolution limits. However, NASA has approached the problems of the future orbital height, orbital planes, and orbital path of the Landsat D satellite from the point of view of optimizing spacecraft design rather than the data product. This approach has resulted in abrupt changes in data format, to the discomfort of the potential purchasers of the data. Consequently, the user community displays considerable skepticism about the NASA's or NOAA's ability or commitment to operate a full civil land satellite remote sensing system tailored to providing standard and predictable data products.

- Continuation of remote sensing R&D. The current Landsat capabilities, though they satisfy the needs of a large portion of the potential users, are also limited.

  Users interested in non-renewable resources would like to have stereo imagery. Cartographers would benefit from both stereo and higher resolution capabilities. Even the heavy users of current Landsat data will find their needs expanding as they gain experience with the data and understand their potential. They are likely to find needs for new sensors and advanced data relay subsystems.

- Price of data. The major concern of the users with regard to price of data is that price increases be reasonably predictable and incremental.

  Current data prices are much lower than the marginal costs to generate the data. Users recognize that future data prices will be higher as the prices are increased to reflect marginal costs. However, users cannot purchase the same volume of data if the prices are doubled or tripled. Some state and local government users also face the difficulty of a two year budget cycle. If data prices are raised precipitously, they cannot adjust to the increases for up to two years, and will be forced to purchase fewer data than their needs would actually dictate.

The striking feature about this list of user needs and elaboration of their concerns is that most problems derive from the terrestrial segment of the system. On the whole, these are not hardware technology problems, but rather ones of management and structure of the system. The larger problem, at least in part, seems to be that NASA, in an effort to test a broad spectrum of applications and to interest the potential users around the world in relying on remote sensing data, created a de facto operational system. Their effort was driven, in part, by a desire to justify the R&D program to the Office of Management and Budget. However, being by long established policy an R&D, not an operations agency*, NASA has not been motivated to manage an operational satellite remote sensing system, and has therefore been unable to guarantee its continuity. NOAA, in turn, is not scheduled to assume the management of the system until 1983 (after Landsat D is launched). Circumstances such as these have had made the users extremely wary of investing in the manpower, hardware and software to process Landsat data because the future of such systems is uncertain. Further, this uncertainty has limited the size and vitality of the market for Landsat data as well as that of the data processing (value-added) industry.

In short, satellite land remote sensing has fallen into the following Catch-22: the users refuse to invest further in Landsat data because the system is not operational but they also oppose changes because they are using the system as if it were operational. On the other hand, no existing institution, federal or private, seems appropriate to undertake operations, first, because there are not enough users, and second, because the present system is not good enough.

The Market for Satellite Remote Sensing Data

Whether a space remote sensing system is operated by the federal government or by private industry, the strength of the market for the data it supplies is of major concern. In either case, full recovery of the costs of investment and upkeep (particularly those of the space segment) is problematic. In a publicly-owned system, accrued political benefits, such as its use as a tool of foreign policy or its value in enhancing U.S. technological superiority, may justify a reasonable shortfall in cost recovery. But in a privately-owned system operating with no taxpayer subsidy, the market alone must bear the entire burden of recovering these costs. Market strength is therefore crucial to the success of any operating system: without it, shortfalls in cost recovery are almost inevitable. For a publicly-held system, a shortfall must be kept within politically defensible bounds; for a privately-held system, any continued shortfall is intolerable.

The market for remote sensing data from space divides naturally into two categories: The market for primary data provided directly from the space segment, and the much more lucrative market for value-added data, which represents the ground segment. Based on our review of the size and nature of the market, we can make the following observations:

- Size of the market The true extent of the market for primary satellite remote sensing data is unknown. The domestic market consists of two kinds of users, the government (local, state and federal) the private-sector. Federal government users generate the largest demand in this category today. Although the records of the EROS Data Center and the NASA Goddard distribution center indicate a relatively small primary market (approximately $5 million per year), some observers assert that this estimate reflects only a portion of the true market. Some users obtain data from other users at a portion of the original cost, or for free (i.e. a certain amount of data sharing occurs)

o Even if the exact distribution of original satellite data were known, however, it would represent only a fraction of the value of data after they are specially processed to provide particular information. For example, the cost of a CCT is currently $200. To process the data contained on a specific CCT and present it in usable form to the ultimate user of the data can cost between $1,000 and $20,000, depending on how much information is extracted and the steps taken to enhance the original information. Processing satellite remote sensing data thus represents a significant investment opportunity for a firm, especially one that is already capable of digitally processing remote sensing data from aircraft. Currently, some 60 firms are known to be capable of processing Landsat digital data. Another 35 firms (28 U.S., 7 foreign) sell computer processing equipment for Landsat, which ranges in price from $50,000 to $500,000. Firms which digitally process photographic data might also be interested, because the basic techniques for enhancing image data by computer are similar for all applications, though most film processors would lack the analytical expertise in land resources.

- Nature of the market. One of the major difficulties in defining the full extent of the market is its extremely diffuse and disaggregated condition. Each major category of user, both the foreign and domestic, has different sensor requirements, is interested in different geographical areas, or needs data on a different time schedule. The following broad categories of users and their general needs for Landsat data exist:

Table 1

- AGRICULTURE (federal, state, private): Specific sampling areas chosen according to the crop; time-dependent data related to crop calendars and the weather patterns.

- FORESTRY (federal, state) Specific sampling areas; twice per year at pre-selected dates.

- GEOLOGY AND NON-RENEWABLE RESOURCES: Wide variety of areas; seasonal data in addition to one-time sampling.

- CIVIL ENGINEERING AND LAND USE (private): Populated areas; repeat data required over scale of months or years to determine trends land use.

- CARTOGRAPHY (federal, state, private): All areas; repeat data as needed to update maps.

- COASTAL ZONE MANAGEMENT: (federal, state): Monitoring of all coastlands at selected dates depending on local seasons.

- POLLUTION MONITORING (federal and state): Broad, selected areas; highly time-dependent needs both for routine monitoring and in response to emergencies.

In order to understand fully the data needs of each user group, it would be necessary to analyze in detail the records of the EROS Data Center, the NASA Goddard data processing center, and the foreign ground stations to determine:

Who use the data (specific users identified by discipline)?

What regions are requested (frequency of request, and timing)?

From this information and a projection of user requirements, future market potential might be determined. To this could be added predictions about new markets, foreign and domestic. To our knowledge, no analysis has reached the level of detail required for making reasoned decisions about the potential for commercialization of the technology.

Commercialization of Remote Sensing

Both the previous and current administration have been committed to commercialization of civil land remote sensing satellite activities. The major questions before the Congress at this time are how and at what speed the transition to the private sector should be accomplished. The conversion from public to private ownership and operation of the civil land remote sensing system will affect the user community in a variety of ways. Users perceive that both advantages and disadvantages will result from the change. In addition to the user concerns previously expressed in relation to an operational system, independent of who runs it, they have raised the following concerns specific to a commercial enterprise:

- Open data policy. The U.S. currently supports and subscribes to the policy that any party, regardless of nationality, may purchase any Landsat data, regardless of source. Users fear that this policy may be discontinued. The question of whether unrestricted dissemination of remotely-sensed data violates the sovereignty of a sensed nation has occasioned vigorously debated in the UN and other forums for many years, with no agreed-upon solution. The U.S. position has been that civil remote-sensing data shall be made available to all, but many countries have objected that they do not wish important information about indigenous mineral resources, crop conditions, and military activities to be made public. Private operation may heighten supicion that such data will be used to enable outside firms to gain a competitive advantage, or that data may be sold secretly to political adversaries. These concerns will sharply increase as new sensors improve upon the current resolution of 80 meters for the MSS aboard Landsats 2 and 3 (to 30 meters for the Thematic Mapper (TM) on Landsat D and 20 for the SPOT sensor).

o Resolution limits. What regulations will be imposed concerning the limit of resolution of the sensors? The TM on Landsat D and D' will be capable of 30-meter resolution. Will 30-meter data be available from any region of the world or will there be restrictions on dissemination of the data from some areas? For some applications (e.g., forestry), resolutions of 1 - 5 meters would be useful. Further, as other users become more accustomed to the capabilities of remote sensing and their ability to handle massive mounts of data improves, they are likely to find need for data of higher resolution. As in other aspects of satellite remote sensing, users want to be involved in the decision-making process for determining the limits to resolution. As outlined above, the resolution limits will also be of major international concern.

o Competition from governments. Both the potential operators of remote sensing systems and the value-added firms are concerned about potential competition from governments, either the U.S. or foreign entities. For example, NASA now competes with private industry when it institutes an R&D project in a university or government facility to process Landsat data. These projects result in computer software which competes directly with software packages developed by private value-added data processors.

- Price of data. The user community is quite concerned about the price of primary data from a privately-owned satellite system. Users fear a dramatic increase in costs. For a few users, whose needs are largely one-time data from a particular region, the cost of a single CCT is not as critical as it would be for users who require repeat data on a time scale of weeks or months. It is highly doubtful that the price elasticity is sufficient to allow prices to be raised to a full cost recovery level in the next few years.

- Continuing federal research and development. Users recognize that neither they nor the actual operator(s) of land remote sensing is (are) willing to provide the resources to fund continuing R&D in the private sector. Yet there are a number of improvements which could be made to the system even after Landsat D and D' are operational. Users therefore see the need for continued research by the federal government, with sufficient involvement by the user community in the decisions about the directions such research should take.

- Archived data. What will happen to the archived data which have already been taken by Landsats 2 and 3 and other means when the private sector assumes responsibility for the Nation's satellite remote sensing activities? Users are very concerned that the previous data be retained (see above - Criteria for an Operational System). But retaining them is very costly since HDDT's have a limited lifetime and, therefore, must be recopied at regular intervals.

- Models for remote sensing corporations. Users with whom we discussed this were less concerned about the specific models that might be used than that there be a working system for civil satellite land remote sensing. They were generally cautious, however, about applying the models from the development of the satellite communications industry without careful study. Satellite communications began under circumstances very different from those that exist for remote sensing. It began and grew in the context of a strong, aggregated private sector telecommunications market. The tasks involved in achieving international cooperation and agreement about satellite communications, though burdensome, were simple compared to the potential problems of reaching agreement about private corporate satellite sensing of other nations.

The best way to achieve eventual full private-sector ownership of the satellite remote sensing system may be to separate the space and the terrestrial segments into two distinct entities. Each could be commercialized at a different rate. However the transfer is finally achieved, the users clearly wish to have a strong voice in the process.

In summary, it is clear that the user community has experienced considerable frustration in trying to work with the current land remote sensing satellite system. Users are concerned about their future ability to obtain satellite data, for in spite of the problems they have faced, they see the system as an important adjunct to their respective missions as government agencies or private concerns. For them the two most important issues are 1) maintenance of the data flow, and 2) the direct inclusion of their interests in the decision-making process.

We asked the participants in our users' workshop to specify the minimum system they would like to see operating until a more sophisticated system could be built and tested. While recognizing the complexities inherent in the question, they agreed on the following minimum attributes for an operational satellite remote sensing system:

- Simple sensors for different spectral bands already tested in the space environment, such as multi-spectral scanner (MSS) and perhaps a return-beam vidicon (RBV) sensors or a multi-linear array (MLA) of solid-state detectors.
- At least 30-50 meter resolution
- Stable CCT format over time

- Adjacent-swath orbital coverage
- S-band down-link
- Simplified data transmission and reception
- Current processing techniques and enhancement technology.
- Better on-board tape recorders to augment direct return of data.

A system with these attributes would satisfy many of the needs of today's user community and would also provide the operational base from which to build and test more powerful and more complicated systems. It would also test the reasonable hypothesis that a strong market for remote sensing data will develop when a dependable system exists.

APPLICATIONS OF REMOTE SENSING TO PETROLEUM EXPLORATION[1]

by

Michel T. Halbouty[2]

The world's resources reserve base is declining - - and in the future will decline at a more precipitous rate unless new reserves are discovered and produced within a reasonable time frame.

Even though the world has begun a transition period from conventional oil and gas energy toward alternative sources of nuclear, coal, geothermal, solar, fusion and synthetic fuels, it is evident that for at least the next three to four decades the major means of world energy survival will depend on oil and natural gas supplies. Petroleum is still King!

Numbers of possibilities exist for increasing the world's supply of energy from petroleum as well as from other sources, but lead times to achieve commercial production are very long, resulting from delays in demonstrating new technology, obtaining regulatory permits, providing environmental safeguards, developing infrastructure in remote locations, and completing financial arrangements.

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The easier-to-find petroleum resources have been found - - it is now imperative that we hunt for and discover the harder-to-find reserves on a global basis. The world's scientists and technologists must use every means and method to further the search for new reserves.

Generally, four basic steps in petroleum and mineral exploration are (1) regional geologic reconnaissance and cursory appraisal of geomorphic features; (2) detailed geologic surface and subsurface mapping; (3) ground geophysical exploration supplemented, if warranted, with aerial geophysical surveys; and (4) actual drilling and mining operations.

Each succeeding step is more expensive than the preceding one, and for economic reasons every available means must be employed to reduce the total exploration costs without sacrificing efficiency or the accumulation of necessary scientific data.

Aerial photography from space has given the geoscientist a new dimension in looking at the earth.

(Slide 1)

The earliest photographic experiments in space on the Mercury, Gemini, Apollo, and Skylab flights showed the value of the space perspective for study of the earth. The coverage provided from these missions, however, was never sufficient to do more than tantalize the prospective users of space data.

It remained for the land satellite launched in 1972 which extended the application of space remote sensing to all areas of the world and to spectral regions never seen by man before.

Landsat provided the repetitive coverage necessary to the study of dynamic phemomena on land, in the atmosphere and oceans.

Remote sensing utilizing Landsat imagery is one of the newer tools aiding the explorationist in his search for future reserves, domestic as well as worldwide. It provides a means for obtaining valuable data which can contribute to the exploration effort in any region of the globe and at the same time it considerably reduces the total costs of exploration.

Geologists involved in mineral resources have adopted use of Landsat data not only in exploration but also in development and production phases. Many petroleum geologists have not fully adopted Landsat nor realized the availability and importance of its applications to the everyday exploration effort.

One fact emerges from the analyses of many Landsat images: remote sensing using Landsat data can be of vital assistance to the petroleum explorationist in his search for oil and gas - - whether the search is conducted in old or new areas.

Some direct applications of Landsat imagery to petroleum exploration can be seen in the following slides.
(Slides 2 and 3)

Landsat imagery can be used effectively to outline sedimentary terrains and to determine the areal distribution of key strata and their relation to regional structure - - a significant prerequisite in evaluating the petroleum potential of an area.

For example, one such image of interest covers a portion of the Tsaidam basin in China, shown on the left screen, and another in western Saudi Arabia, shown on the right screen.

The basin is a large intermontane sedimentary feature in the arid northwestern part of the People's Republic of China. The basin covers an area of approximately 100,000 square kilometers, and is enclosed in a triangle formed by three major mountain ranges.

The basin has been the site of active deposition since at least late Jurassic time, when uplift of the surrounding mountain ranges and coincident basin subsidence commenced.

Subsequently as much as 14,000 meters of lacustrine and other associated continental sediments were deposited. Compressional and extensional deformation of the basin sediments, occurring mostly during the Tertiary and Quaternary, resulted in the formation of many large folds potentially favorable for the entrapment of oil and gas. Many of these favorable features are shown on this images.

The right screen is a scene of the complex Precambrian structural style of metamorphic and igneous rocks bordering the Red Sea in western Saudi Arabia.

Felsic Precambrian intrusives are characterized as low-relief, light-toned, elliptical areas within the darker, well-foliated, metamorphic complex.

The truncation of the older north-northeast-trending structural belt against the north-northwest-trending belt is the most conspicuous tectonic feature on the image.

Younger, post-Precambrian, mafic volcanic centers and geomorphic features are superimposed on the older trends and are related to Red Sea rifting in Tertiary time.

In addition to outlining sedimentary terrain and aerial distribution of key strata and their relation to regional structure as shown in the two slides, there are many other applications of Landsat data which can materially assist the overall exploration effort.

Probably the greatest discovery directly attributed to the analysis of synoptic data from Landsat was the recognition of linear alignments of landscape features which often extend for tens of kilometers.

Although intensive studies have been made to assess the geological significance of lineaments, the consensus among earth scientists is that these lineaments are thought to represent the surface expression of fundamental changes of the earth's crust.

(Slide 4 - take 3 off right screen)

Lineaments are often of dimensions which make them not apparent to gound-based geologists and often displacements on such features are so slight that they are not easily recognized as structural discontinuities, even when subsurface well-bore data are available.

Yet, evidence is now becoming increasingly accessible from practicing explorationists that many of these linear trends in basin areas can be interpreted as bounding structural blocks in the basement. The geometry and even slight displacement of basement blocks often affects basement sedimentation patterns which, in turn, may influence the accumulation of hydrocarbons. Many petroleum geologists are now using Landsat data operationally to target petroleum exploration in basin areas by evaluating lineaments in this manner.

For example, one major oil company recently announced that it had completed testing a series of very successful wells in Sudan - - all of which were drilled on the basis of Landsat analysis of lineaments coupled with aircraft and ground-based surveys.

The slide on the left screen is a map showing major linear features in the United States. It has been definitely determined by geoscientists that significant correlation is thought to exist between these linears and the presence of minerals, petroleum and geothermal sources.

Also, the structural significance of these lineaments on the earth's crust is emphasized by the merging of three particular major lineaments: one extending northwestward from Florida, another trending southwestward from New England, and a third extending southward from Lake Michigan.

The intersection of the three lineaments no doubt created a subterranean weakness in the earth's basement and crust which was instrumental in causing the extremely severe New Madrid, Missouri, earthquake in 1811.

It is also of economic significance to note that the Missouri lead zinc district is also located near the intersection of these lineaments. Mineral and mining geologists are currently mapping all linear features - - small or large - -

in their areas of interest, as they fully recognize that the proper interpretation of these linears could lead to substantial mineral deposits.

Mineral explorationists have been very active in evaluating lineaments displayed on Landsat imagery to develop exploration models based on the identification zones of weakness in crustal materials in the metallogenic evolution of exploration areas.

(Slides 5 and 6)

Detection of surface alteration zones with multispectral satellite data has been somewhat successful, but most explorationists feel the wavelength bands of the present Landsats are not optimized for the detection of such zones.

Another important contribution of the Landsat program has been the acquisition of repetitive coverage and recognition of its significance for geologic application. In many areas of the world landscape cover changes with seasons and so do landscape illumination conditions.

These two slides reflect the seasonal influence on imagery. The dramatic differences between the dry and rainy season images are shown in the western Transvaal Province of the Republic of South Africa.

An image acquired at the end of the dry winter season is shown on the left screen and one acquired in the middle of the summer rainfall season is shown on the right screen. The area is a grass-covered plateau where the more resistant rock units form conspicuous ridges.

The current trend in the utilization of Landsat data in both mineral and petroleum exploration is to mate these data with geophysical, geochemical, topographic, surface and subsurface geologic data. The combined sets are then simultaneously analyzed to produce exploration models which will limit requirements for ground-based exploration.

In order for explorationists to effectively use globally acquired data from advanced earth resources satellites, efficient means of rapidly distributing the data and compatible formats for the data must be developed.

Although the current Landsat data handling system has been greatly improved in terms of delivery time and product quality, explorationists in the field will require relatively fast data at locations which are remote to data archives.

This will be especially true of requests for high spectral and spatial resolution coverage over small areas. It is not inconceivable considering current trends in technology to imagine a system whereby an explorationist using a small portable terminal could directly access a global earth resources data base to determine what data are available.

Over the past few years I have become involved in studying Landsat images of known petroleum producing areas of the world. By working with available data on these "known" fields, I have gained insight into the applications of Landsat imagery to the "unknown" areas - - the frontiers, and the previously unexplored or unmapped areas of the world.

The following discussion with illustrations is predicated on the assumption that the giant fields discussed herein had not been discovered prior to the Landsat imagery interpretation.

Given the knowledge of the interpretation of these various images, what I will be showing you is how the use of Landsat data could have proved most beneficial to the eventual discoveries if these images had been abailable before any exploration of any kind had been conducted in the areas where these giant fields exist.

(Slides 7 and 8)

The Buzurgan oil field in Iraq, shown on the left screen, was discovered in January of 1970. It is 31 miles long and 5 miles wide and is part of the Zagros Foothills thrust belt. The field is located on a prominent anticline. The areal closure is 155 square miles and the verticle closure is 400 feet.

The oil column is estimated to be approximately 500 feet. The major oil production is from the Mishrif limestone formation, middle Cretaceous, at depths of approximately 10,500 feet.

Minor oil production is from the Zubair sandstone formation, Lower Cretaceous, at approximately 13,000 feet. Ultimate recoverable reserves for the field are placed at 1.1 billion barrels of oil.

Working only from the geological interpretation of the Landsat image as shown on the right screen, an explorationist could have made the following observations:

The delta of the Tigris River covers most of the image area, but the foothills of the Zagros are visible in the northeast corner. Folds in the bedrock area trend north-

northwest by south-southeast and can be plainly seen. Offset within the folds suggests a later faulting with right-lateral strike-slip displacement. This strike-slip displacement may be a fault within a thrust sheet whose leading edge has been covered by alluvial deposits.

The most prominent anticline is cut by a fault with apparent right-lateral displacement.

The circular anomalies are tonal features which indicate some structural relation. The lineaments shown in the west-central part of the figure are probably structurally influenced. In the center of this image, there is a major stream deflection and anomalous drainage pattern related to the Tigris River.

Had this image been available, it would have been a most useful and only exploration tool required in the discovery of the Buzurgan field and in also delineating the many other prominent anticlines and geologic features in the image scene. (Slides 9 and 10)

These images are of the Burgan oil field in Kuwait. Burgan is located approximately 28 miles south of the town of Kuwait and 14 miles west of the coast of the Arabian Gulf. The Burgan structure is anticlinal. The crustal depth is approximately 3600 feet. Three oil fields - - Burgan, Magwa, and Ahmadi - - are interconnected by continuous oil-bearing hroizons and are collectively referred to as the Greater Burgan field. The producing sand sequence is of middle Cretaceous age. The net thickness of the sequence is more than 1000 feet and the producing zones are highly porous and permeable.

The depositional environment is considered to be shallow-water shelf, probably on the edge of a delta. Ultimate recoverable reserves are estimated at 66 billion barrels of oil.

The Landsat geologic interpretation of this field suggests that in the Burgan area the linear trend is a low, gentle, east-facing escarpment.

There are three types of anomalies visible on the image: (1) The smallest anomalies are similar in size to salt domes elsewhere in the Persian Gulf area. With one exception, they are located east of the escarpment in the relatively sand-poor coastal zone. An intensively cultivated lowland adjacent to the Gulf forms a larger anomaly. (2) Two anomalies have a subtle mottling that may indicate a slight topographic high. (3) A lineament is offset where it meets the northernmost circular anomaly. Although variations in the sand tones delineate the anomaly, the offset suggests possible structural origins.

There is a tonal variation on the image which would have initially been observed as a main feature to be explored. There are two tonal, or surface-expression, anomalies along this north-northwest by south-southeast trend which are outlined with a dot pattern: one west of Burgan and the other south-southwest of the field.

Prior to exploration, this image would have aided the explorationist in his work in this area and would have saved considerable time and expense in pinpointing features on the image for geophysical surveys. A location for the discovery well could have easily been made from the interpretation of the land satellite data.

(Slides 11 and 12)

The Kangan field, discovered in 1973, is located in the Fars Province of Iran within the Zagros Foothills thrust belt.

The gas-bearing horizons in the Kangan field are located in the Lower Triassic to Permian Khuff Formation, constituted mainly of heavily fractured dolomitic and oolitic carbonates of intertidal origin - - thin layers of anhydrite form the cap rock. The Kangan field structure is a compressional folded anticline and has a gas column of approximately 3,000 feet.

The ultimate recoverable gas reserves are estimated at 100 Tcf.

The Landsat interpretation yields the following information.

The area of interest is a large anticline, which can easily be seen on the image, and is located on the western margin of the Zagros Mountains, an intensely folded region in southeast Iran. Near the north nose of this fold a pair of faults dissects the structure and appears to extend west to the neighboring refolded anticline.

The arrow points to a light-toned outcrop - - an exposed salt diapir - - between the two faults, which can be seen clearly in the unannotated image. An exposed diapir would account for the disruption of the strata on the north end of the refolded anticline.

The image clearly indicates that the entire land area has been subjected to compression and folding and that erosion has exposed the upper parts of the folds.

The image clearly indicates that the entire land area has been subjected to compression and folding and that erosion has exposed the upper parts of the folds.

Displaced anticlinal flanks mark the location of other faults in the image area. Neighboring images indicate that faulting increases to the east. Further image analysis indicates that there is an abundance of possible petroleum traps such as anticlines, diapirs, and faults.

Landsat would have been most useful in the initial exploration of this area. It would have aided the field geologist in tracing the resistant strata over long distances; the geophysicist in locating lines to cut across all the major structures with the least amount of topographic interference; and would have been encouraging to the wildcatter to drill on the Kangan structure - - which, after all - - is the largest anticline on the scene.

There is no question that this image, if it had been available, would have assisted the exploration team in its efforts and would have materially and economically enhanced and hastened the discovery of this giant field.
(Slides 13 and 14)

The next images are of the giant gas-condensate Malossa field in northern Italy. The field is situated in the northern Po basin which covers an area of approximately 19,305 square miles.

The Malossa structure, discovered through seismic exploration, is a faulted and overthrust anticline about 3 miles long and 2 miles wide bordered on the southwest by a reverse fault and on the east by a normal fault.

The discovery, and first, well at Malossa, spudded in 1972, was drilled to a depth of 18,891 feet in February 1973.

Deepest test in the field to date, Malossa 2, reached 21,230 feet and was bottomed in the Middle Triassic dolomites of the Esino formation. Principal pay zones in the field consist of Upper Triassic dolomites and dolomites of Early Jurassic age.

The productive interval encompasses beds which extend from Upper Triassic through Lower Cretaceous. The pay section in the gas-bearing beds totals 2,700 feet. The ultimate recoverable reserves of Malossa are estimated at 284 million barrels of oil and 2 Tcf of gas.

The geologic interpretation of the Landsat data indicates that as in several other images in this study, intensive cultivation of the valley plain obscures the surface expression of geologic features. However, two image patterns of possible anomalous importance can be seen.

The area of great interest to the interpreter would be the large circular anomaly in which a smaller one is defined by relatively high reflectance aorund which the Adda River is diverted. It just so happens that is where the actual field is located. A similar area with curvilinear drainage segments is present near Verona to the east.

The Po River contains several anomalously straight segments of drainage oriented approximately east-west. The Po River Valley contains a series of east-west faults, one of which forms the structural trap for the Malossa field. The strong east-west lineament, shown by a green dashed line, could have been influential in the trapping of the hydrocarbons.

Although its cause is unknown, the large tonal anomaly containing the Malossa field is the most obvious feature in the Po River Valley. The similarity of the large Malossa anomaly to the one on the east establishes the latter as a potential exploratory target. Also of prospective interest is the north-south anomaly near Verona.

If this image had been available and properly interpreted prior to any exploration in this area, the anomalous areas would have been pinpointed for seismic surveys which would have advanced the discovery of the Malossa structure and field.

(Slides 15 and 16)

The Samotlor oil field is located in the Middle Ob region in the West Siberian basin of the USSR. The basin is considered to be one of the largest in the world.

The field was discovered in 1965 by the first exploratory well which was located from seismic surveys. The field is on a large anticlinal closure. Productive horizons are within a section 1,925 feet thick, ranging in age from Upper Jurassic to Lower Cretaceous-Cenomanian.

The reservoir rocks are shallow-marine shelf sandstones interbedded with shale at depths between 5,000 and 7,000 feet. The total recoverable reserves are estimated at 15 billion barrels which by the way is ½ of the total oil reserves in the United States.

The geologic interpretation of the Landsat data indicates that the feature is a large, gently sloping plateau encircled by two river systems. The drainage has been diverted around a topographic high which may reflect a bedrock high. Two arrows point to abrupt changes in the rivers' courses that support the idea of structural influences.

In the northern valley the river makes a bend north of the oil field. In the southern valley, the river flows into the oil field area and then makes a 90° turn to continue in a direction parallel with the elongation of the field. The crosses on the geologic interpretation indicate areas of blocky or rectangular drainage which suggest a relatively flat-lying, jointed bedrock, possibly limestone.

In the northeast part of the image, there is a very interesting geomorphic feature. The dip symbols show apparent dip of the bedrock and drainage direction.

Most of the linear features on the image parallel the northeast-southwest stream direction. However, a series of northwest-southeast linears occurs in the vicinity of the field and parallels its direction of elongation.

Investigation of the structural origins of these northwest-southeast linears could yield valuable information for the development of the Samotlor field and for exploration in the surrounding area, making it a primary target for seismic crews.

Had the image been available prior to exploration, the large gently sloping plateau encircled by two river systems would have delineated the area of interest for exploration which surely would have resulted in the discovery of the 15 billion barrel Samotlor oil field.

(Slides off - lights)

Utilizing what knowledge is gained from the intense examination of the existing known petroleum accumulations worldwide, it is definitely within the realm of probability that similar investigations and interpretations of heretofore unexplored or unmapped areas will result in the finding of significant hydrocarbon reserves. Also, future exploration in mature areas would benefit by such intensive investigation and reinterpretation.

Now let's review some of our government policies. In the past, our government has taken the position that the development of exploration technology is an industry responsibility. The growth of the geophysical service industry is often cited as an example of why government should not be involved in development of exploration technology.

The results of the government's attempts at exploration for petroleum correctly attest to the fact that government should leave the actual conduct of energy exploration to industry. However, accelerated development of some exploration technologies is beyond the resources of the energy exploration industry and is badly needed to improve the effectiveness of global exploration.

Because of uncertainties in the market for data products and uncertainty about capital investments, industry has not been willing, and justly so, to alone take the initiative in advancing remote sensing technology.

The position taken by the United States Government last year was, if our petroleum industry wanted global stereoscopic image data to find energy more effectively, that industry should pay for development of the satellite system. As a result of lack of government initiative, the development of our own stereoscopic mapping satellite was shelved.

The governments of other countries work closely with their energy industries to develop and apply new technology, but the United States Government has not directly encouraged or supported the development of improved exploration techniques.

For example, the mineral and energy exploration satellites under development by France (SPOT) and Japan (MERES) will lead to their use by their petroleum industries by 1984 and 1985.

One of the major thrusts of a new energy program should be to aggressively support immediate development of new exploration technology that is beyond the control of industry.

Secondly, to evaluate energy alternatives and formulate energy policy, global information is required by government agencies. The same information is also used by the energy industry in evaluating areas for exploration.

Recent speculative reports of large petroleum discoveries in the Soviet Union, and large variations in estimates developed for areas where ground-based geological data is unavailable, have highlighted the need for better global coverage.

There is a need for more of this information to be based on systematic evaluation of the petroleum geology. The new energy program should support the development of new technologies and methodologies which will improve the efficiency of systematic geologic evaluation of energy resources.

Our country must continue to develop programs which will provide not only improved repetitive, global, and synoptic multispectral data of the Earth's surface, but also global geophysical and topographic data as well.

The energy exploration industry has recommended to NASA that a stereoscopic imaging satellite be flown as soon as possible to acquire global data for analysis of energy-related geologic structures.

A recent study contracted for by the Department of Energy, to evaluate "Satellite Remote Sensing in Energy Research and Development", supported the view that acquisition of global stereoscopic data would be of great benefit to government energy-related activities.

Geologists from the petroleum industry, at a conference in Snowmass, Colorado, in 1979, unanimously recommended to NASA that an imaging radar satellite be launched as soon as possible to permit more efficient energy exploration in cloud-covered and vegetated areas.

Although satellite measurements of the earth's gravity and magnetic fields have provided valuable insights into the size and geometry of large petroleum basins, global higher-resolution measurements of the earth's potential fields are necessary if energy explorationists and government resource analysts are to use this data to substantially improve the efficiency of geological exploration and resource evaluation.

The critical national need for accelerated discovery and development of energy resources dictates requirements for improved global exploration tools and better methods for developing geological information on energy resources.

Our energy policy must aggressively support development of those technologies which can be immediately placed into service for finding more energy in the short term. Over the long run, our policy must support research and development of high technology which will ultimately lead to improved methods of finding and evaluating energy resources.

For example, although Landsat provided access to previously uncharted areas of the world, the earth scientists and mappers remain frustrated by the lack of high resolution stereo imagery from space.

(Slide 17)

The space shuttle might hold some of the answers to economically map the world from space. NASA owns one of the finest cameras in existence today, the large format camera. This camera can cover most of the world in stereo--also in color--and with a resolution which surpasses that of any other planned sensor.

(Slides 18 and 19)

The difference in the resolution of the large format camera (LFC) and a landsat image is shown on the slide on the right. The clarity and natural color of the LFC image are noteworthy.

It may be possible to attach the LFC to the space shuttle in its various flights. It would take at least 10 orbits of the shuttle to cover most if not all of the world. Stereo, color, and the extraordinarily large area covered by each LFC frame, which is 3 times that of Landsat, will significantly increase the productivity of the users of space data.

Another example is the NASA Landsat D global satellite information gathering program. Landsat D, with the thematic mapper, represents the first significant improvement in space remote sensing with respect to global mineral and energy exploration in ten years.

Experimental work funded in large part by private enterprise shows very promising results; that is, the ability to more definitively discriminate certain rock types and vegetation that correlate with energy and mineral resource deposits. (Slides 20 and 21)

Silverhill porphory copper deposit, Arizona--color film showing open pits--the dark band is iron oxide capping of the ore body.

This is the same scene with the thematic mapper simulator using 6 bands including 2.2 over 1.6 micron ratio. Indicates iron oxide (green) and alteration clay (red) = yellow orange. Whole alteration zone mapped in 30 seconds by the thematic mapper while the superimposed alteration map shown in white took the company 30 years of ground mapping to do the job.

Significant development of Landsat D systems have already been completed at substantial cost. This program should not be permitted to be cast aside, particularly in light of other countries efforts to produce a similar satellite global data base.

Therefore, a government program should be established immediately to promote accelerated implementation of those technologies and methodologies which can be pressed into immediate service in the global search for new sources of energy. The program should promote accelerated research and development of high-technology and new methodologies for future use in global energy resource evaluation.

The Gravsat mission, currently under consideration, would allow geoscientists worldwide to evaluate "the structural configuration and state of isostatic equilibrium of sedimentary basins and continental shields, the structure of plate boundaries, orogenic belts and continental margins, ocean lithospheric features like trenches and island arcs, and density differences in the mantle related to convection."

This mission must not be scrubbed.

With that overview, I must conclude my remarks by stating that appropriate funding for the Landsat program must be continued. If the United States fails to launch its own satellite to obtain the new required data, the industrial complex of the United States will be forced to purchase and receive these data from foreign sources--and it is obvious what would happen. Any orders for data from U.S. companies would be first looked at and analyzed by foreign competitive interests and used to their advantage.

We should not, under any circumstances, depend on other nations for our data. Industry and government should begin to work together on all aspects of future land satellites.

If the government desires industry to participate in future Landsat projects, the government must make some overture to industry.

As to what manner or form this should take, I do not know--I can only say that it is imperative that this country continue the investigation of the earth from land satellites--and that industry and government must find a way to do this with mutual understanding of the needs of each other, the needs of the country, and the needs of the rest of the world for this information.

Therefore, it is my thesis that as a geoscientist who has used and appreciated the value of Landsat data, I am of the opinion that in terms of benefit to the world's people--and especially the United States--the United States' Landsat program is probably the most significant mission ever launched by NASA.

But this program is just a start to what can be accomplished with spacecraft to materially assist in the discovery of the world's energy and mineral resources of the future.

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